

FORMULA GR-2

MACHINE SPECIFICATIONS

CAPACITY:

10-3/4" dia. 3 jaw grinding chuck -
Maximum outside diameter of work = 5-1/2"
13-3/4" dia. 3 jaw grinding chuck -
Maximum outside diameter of work = 8-1/2"
Fixture or face plate on spindle nose -
Maximum outside diameter = 16"

WORK SPEEDS:

160 RPM
240 RPM
325 RPM
480 RPM

TABLE TRAVERSE RATE:

0-35 feet per minute (Hydraulic)

WORKHEAD SWIVEL:

Maximum with guard - 15°
Maximum without guard - 35°

AD 600 197

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SECTION I

FORMULA REPORT, WORK SHEETS AND INSTRUCTIONS

HEALD 72-A INTERNAL GRINDER

FORMULA REPORT

FARTS: All parts which are within capacity of the machine.

OPERATIONS: All Internal Grinding, including Traverse, Plunge, Taper, Radius and Face Grinding.

MATERIALS: All materials commonly ground on an Internal Grinder.

WORK STATION: Department 637-1, Heald 72-A Internal Grinder.

ALLOWED TIME: Set-up - Time in decimal hours as computed from set-up work sheet.
Each Piece - Time in decimal hours as computed from each piece work sheet.

ALLOWANCES: All times shown on work sheets and in charts are expressed in levelled decimal hours without allowances. A standard allowance of 15% must be added to all total times to compensate the average operator for fatigue, personal and unavoidable delays, and required wheel changes.

APPLICATION: This Formula applies to all operations commonly performed on the Heald 72-A Internal Grinder.

ANALYSIS: Time values contained in this Formula apply to operations as performed on the Heald 72-A Internal Grinder during October 1956. If there are any future changes in methods, conditions, material, or equipment the time values must be revised to compensate for such changes.

Basic element times were determined by direct observation and application of MTM data. Constant time values shown on work sheets were developed by synthesizing basic elements.

Tools and grinding equipment such as 0"-1" Micrometer, 6" Scale, Allen Wrenches, Open end Wrenches, Diamond Dressers, Dressing "Sticks", and Hammers are assumed to be readily available to the operator, either from his own tool box or from a co-worker's.

Machine equipment such as Chucks, Chuck Jaws, Wheelheads, Face Plates, Grinding Wheels and Blotters, Chuck Spiders, Finger back Stops, Radius Dresser, Quills, and Nuts and Bolts are assumed to be available at the department tool cabinets or wheelhead storage rack.

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Measuring devices and tools such as Height Gages, Verniers, Indicators, Large Micrometers, "V" Blocks, and parallel Bars, which are not specified on the operation sheet must be obtained from the Tool Crib. Special tools and gages listed on the operation sheet are delivered to the operator by the transfer man. The transfer man also brings parts to the machine and removes completed parts. It is assumed that the operator is capable of setting up the machine and making all adjustments necessary to produce dimensionally correct parts. The first correct piece produced by the operator must be checked by the Supervisor and approved before additional pieces are run. The first piece must be submitted to inspection for approval after it is approved by the Supervisor.

PROCEDURE:

Set-up - Operator is assigned a job by his Supervisor, clocks in on set-up and returns to the Supervisor for blueprint and instructions. The operator then studies his operation sheet and blueprint, gets the required tools and equipment and proceeds to set-up his machine. All necessary trial cuts, alignments and setting adjustments are part of the set-up. The operator submits his first correct part to his Supervisor for approval, then turns the part over to Inspection, clocks off set-up and on piece part time, and returns to machine.

Each Piece - Operator gets a part from floor or bench, places it in holding device and performs the necessary grinding operations. All required gauging and machine adjustment necessary to maintain dimensionally correct parts are performed by the operator.

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HEALD 72-A INTERNAL GRINDER

WORK SHEET - SET-UP

Oper. # _____ SP/SG# _____

Inst. No.	"K" No.	Description	Hours	Occ.	Total Hours
1-A	1	Set-Up. Initial And Machine	1.1202	1	1.1202
		Set up Holding Device:			
2-A	27	3 Jaw Chuck	.7186		
B	37	Additional For Finger Back Stops	.2841		
C	35	Fixture	.2133		
D	45	Fixture on Magnetic Chuck	.0256		
E	34	Face Plate	.1965		
F	2	Additional for Workhead Guard	.0273		
G	53	Extended Bridge	.2965		
3-A	38	Set-up: Radius Dresser	.3230		
4-A	21	Align: Wheelhead with Shim	.0531		
		Set-up Stops:			
5-A	11	Each Table Traverse or Stop Dog	.0044		
B	12	One Table Barrel Stop	.0074		
C	13	One Workhead Barrel Stop	.0157		
D	14	Each Additional Barrel Stop	.0202		
6-A	49	Supervisor's First Piece Approval	.1152	1	.1152
7-A		Trial Grind Time Allowed:			
		Each Piece Time _____ x 3 = _____			
		Gage Each Size _____ x .0300 = _____			
		TOTAL _____			

TOTAL TIME _____

ALLOWANCE _____ %

ALLOWED TIME _____

HEAD 72A INTERNAL GRINDER
WORK SHEET - EACH PIERCE

Name _____ Rev _____ Date _____
Super _____ Oper. _____

No.	Description	Hours	Occ.	Total Hours
22	Constant Per Piece	.0066		
43	Handle Part:			
44	5¢ or less	.0035		
44	over 5¢	.0030		
40-42	Holding Device:			
42	3 Jaw Chuck	.0037		
F-3	Magnetic Chuck	.0229		
K-52	Fixture			
	Steady rest	.0037		
10	True-up Part:			
8	Indicator and Hammer	.0167		
	Indicator and Adjusting Screws	.0214		
13	Index Barrel Stop:			
16	Each Table Stop	.0015		
	Each Workhead Stop	.0039		
32	Dress Wheel:			
23	Dresser with Diamond	.0080		
39	Face or Radius by Hand	.0013		
	Radius with Dresser	.0074		
46	DeBurr			
47	One Sharp Edge	.0017		
	Each Additional Sharp Edge	.0008		
	Gauging Required:			
Gau-				

Machine Time:

TRAVERSE GRIND

1-No. of Strokes x Time Per In/Stroke (Ch. 2) x Lgth _____

2-No. of Strokes x Time Per In/Stroke (Ch. 2) x Lgth _____

PLUNGE GRIND

1-Stock Removal x Time Per .001" (Ch. 3) _____

2-Stock Removal x Time Per .001" (Ch. 3) _____

3-Stock Removal x Time Per .001" (Ch. 3) _____

FACE GRIND

Stock Removal (Ch. 4) _____

No. of Rev. x Time Per Rev. (Ch. 4) _____

TOTAL _____

Total Time _____

Allowance % _____

Allowed Time _____

WORK SHEET INSTRUCTIONS
SET-UP

- 1-A Initial and machine set-up is allowed once per job order.
- 2-A Set-up 3 Jaw Chuck is allowed once per job order when a 3 Jaw Grinder Chuck is used as a holding device.
- 2-B Additional for finger back stops in chuck is allowed once per job order where finger back stops are used in a 3 Jaw Grinding Chuck. These Back Stops permit each piece part to maintain a constant location in the chuck. This time is allowed in addition to 2-A..
- 2-C Set-up fixture is allowed once per job order when a fixture is used as a holding device. This time is allowed only when the fixture must be mounted on the machine spindle nose or on a face plate.
- 2-D Set-up fixture on magnetic chuck is allowed once per job order when a fixture is used as a holding device. This time is allowed only when the fixture is mounted on a magnetic chuck.
- 2-E Set-up face plate is allowed once per job order when a face plate is used as a holding device. This time is allowed when either a fixture or a piece part is to be mounted on a face plate.
- 2-F Additional for workhead guard is allowed once when the workhead guard must be removed to permit the workhead to swivel over 15°. Under 15° the workhead can be swiveled without removing the guard.
- 2-G Additional set-up for extended bridge is allowed once per set-up when an extended bridge grinder is used. This time includes setting up a steadyrest and positioning of the workhead on the extended bridge.
- 3-A Set-up Radius Dresser is allowed once per job order when a radius dresser is used.
- 4-A Align wheelhead with shim is allowed once per job order for aligning the wheelhead with shim stock. This time is allowed only when face grinding to a squareness of 6' or less, and/or when face grinding to a dimension of a total tolerance of .002" or less.
- 5-A Set-up each table traverse or stop dog is allowed once per job order for each table traverse or stop dog. Traverse dogs are used only for traverse grinding. The stop dog is used for plunge grinding, face grinding and as a safety stop for traverse grinding.
- 5-B Set-up one table barrel stop is allowed once per job order when only one table stop is required.

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- 5-C Set-up one workhead barrel stop is allowed once per job order when only one workhead stop is required.
- 5-D Set-up each additional barrel stop is allowed once per job order for each additional stop on the workhead or table barrel stop. This time is allowed in addition to 5-B and/or 5-C.
- 6-A Supervisor's first piece approval is allowed once per job order.
- 7-A Trial grind time is allowed once per job order. Each first piece time is obtained by multiplying the total time from each piece work sheet by 3 / checking time. Checking time is obtained by multiplying the number of dimensions to be held in the operation by .0300 hour.

EXAMPLE: Time per piece = .025 hr. - 2 dimensions to be held.
(Time per piece x 3) / (no. of dimensions x .0300 hr.) =
(.0250 hr. x 3) / (2 x .0300 hr.) = .0750 hr / .0600 hr. =
.1350 hr. = Trial Grind Time.

EACH PIECE

- 8-A Constant per piece is allowed once for each piece. One occurrence is allowed for each additional dimension to be ground.
For Example: An operation which calls for grinding two diameters and one face would require two additional occurrences. Additional occurrences are also allowed where close tolerances require a series of sizing cuts. In this case one occurrence is allowed for each sizing cut.
- Rules for determining the number of sizing cuts required:
(1) Diameter tolerance of ".0003 or less allow 3 sizing cuts.
(2) Diameter tolerance of ".0004 to ".001 allow 2 sizing cut.
(3) Step dimension tolerance of -.003 or less allow 2 sizing cut.
- 9-A Handle part 5# or less is allowed once for each piece weighing 5# or less.
- 9-B Handle part over 5# is allowed once for each piece weighing over 5#.
- 10-A 3 Jaw Chuck is allowed once for each piece using a 3 Jaw chuck as a holding device.
- 10-B Magnetic chuck is allowed once for each piece using a magnetic chuck as a holding device.
- 10-C Fixture is allowed once for each piece using a fixture as a holding device. This time is obtained from Formula F-3.
- 10-D Steadyrest is allowed once for each piece when a steadyrest on the extended bridge grinder is used to support a long part. This time is allowed in addition to 10-A or 10-C.

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- 11-A** True-up part with indicator and hammer is allowed once for each piece where a piece part held in a fixture must be trued-up with an indicator and a hammer.
- 11-B** True-up part with indicator and adjusting screws is allowed once for each piece where a piece part, held in a fixture, must be trued with an indicator and adjusting screws.
- 12-A** Index each table barrel stop is allowed once for each additional table stop required.
- 13-A** Dress wheel diameter with diamond is allowed once for each piece. Allow twice when a length of hole to be ground is 3" or more.
- 13-B** Dress wheel face or radius by hand is allowed once for each time the face of grinding wheel is dressed by hand to face grind or to grind a fillet inside a blind hole. Allow once per piece for each face; 1/2 for each fillet.
- 13-C** Dress wheel with radius dresser is allowed once for each time a radius or a grinding wheel is dressed with a radius dresser.
- 14-A** Deburr one sharp edge is allowed once for the first or single sharp edge.
- 14-B** Deburr each additional sharp edge is allowed once for each additional sharp edge.
- 15-A** Gauge time values are obtained from gauging Formula GAU-1. Allow sufficient gauging to insure the accuracy of the operation sheet tolerances and naval ordnance specifications.

Rules to determine the approximate number of gaugings required:

- (1) When the tolerance of a diameter exceeds .003 the allowed inspection time (Chart 1-C from NOPF Gauging Formula GAU-1) shall be used. For a tolerance of ".002 and under the following rules will apply.
- (2) For a tolerance of ".0011 to ".002 allow 1 gaging
- (3) For a tolerance of ".0007 to ".001 allow 2 gagings
- (4) For a tolerance of ".0004 to ".0006 allow 3 gagings
- (5) For a tolerance of ".0003 or less allow 4 gagings
- (6) When a tolerance of a step dimension exceeds ".005 allow 1 gaging
- (7) For a step dimension of ".003 to .005 allow 2 gagings
- (8) For a step dimension of less than ".003 allow 3 gagings

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- 16-A Machine Time - Traverse grind values are computed from Chart #2. Chart #2 shows the recommended amount of stock to be removed per stroke for a given material and the time in decimal hours for one inch of stroke.
To obtain the number of strokes required, divide the total stock to be removed by the amount of stock to be removed per stroke.

EXAMPLE: Grind a hardened steel bore diameter 3.000" long from 1.380" diameter to 1.406" diameter and hold a 32 micro finish.
The amount of stock to be removed = .026"
From Chart #2: Stock to be removed per stroke = .0002"
From Chart #2: Time per one inch per stroke = .0003 hr.
From Chart #2: 8 additional strokes for 32 micro finish. The number of strokes = (.026 divided by .0002) ÷ 8 = 130 ÷ 8 = 138
Traverse Grind Time = Number of strokes (138) x Time for inch stroke (.0003 hr.) x length of Bore (3".000) = 138 x .0003 hr x 3".000 = .1242

- 16-B Plunge grind values are computed from Chart #3. Chart #3 shows the time in decimal hours to rough grind .001" stock of a given material and the time to finish grind.

EXAMPLE: Plunge grind a carbon steel part, whose bore diameter is 1."435, to a finish size of 1."448 diameter.
From Chart #3, using 1 1/2" bore dia. as the next higher dia. and under the carbon steel column, the time to remove .001" stock = .0013 hour.
The amount of stock to be removed is .013 (1."448 - 1."435 = .013")
The time to remove .013" = (13 x .0013 hour) + (4 x .0013 hour) (see note Chart #3) = .0169 hour + .0052 hour = .0221 hour

- 16-C Face grind values are obtained from Chart #4.
EXAMPLE: Face grind an alloy steel part with a workhead speed of 160 RPM and .008" stock to be removed. A required 32 RMS (finish) must be obtained.
From Chart #4 obtain the time to remove .008" stock = .0046 ÷ 10 revolutions of workhead for a 32 RMS (finish) with a time value of .0001 hr. per rev. = .0046 hr. ÷ (10 x .0001 hr.) = .0046 hr. ÷ .0010 hr. = .0056 hr. = total time.

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SECTION II

CHARTS

HOFF GAUGING FORMULA GAU-1
Chart 1

Use	Instr. No.	"K" No.	Description	Allowed Time
6"				
Scale	1	K-2	Scale dimension to 1/16"	.0025
12"				
Scale	1	K-3	Scale dimension to 1/16"	.0036
36"				
Scale	1	K-4	Scale dimension to 1/16"	.0050
	2	K-50	Additional for reading scale to .010	.0080
		K-5	Measure dimension up to 3". Read to .001	.0056
Outside Micrometer	3	K-6	Measure dim. over 3" up to 12". Read to .001	.0075
		K-7	Measure dim. over 12". Read to .001	.0092
			Add. for reading mic. closer than .001	.0018
		K-11	Measure dim. 0" to 4". Read to .001	.0118
Inside Micrometer	4	K-12	Measure dim. over 4" up to 12". Read to .001	.0124
		K-13	Measure dim. over 12". Read to .001	.0151
			Add. for reading mic. closer than .001	.0018
Depth		K-15	Measure dimension up to 3"	.0062
	5	K-16	Measure dimension over 3"	.0067
Micrometer		K-17	Additional for a difficult position	.0023
Vernier		K-36	Measure dimension under 12"	.0132
Calipers	6	K-37	Measure dimension over 12"	.0156
Depth				
Vernier	7	K-38	Measure dimension 0" to 12"	.0140
Vernier		K-40	Measure dimension	.0167
Height Gauge	8	K-44	Measure dim. with Indicator & Gauge Blocks	.0159
Telescope or Ball Gauge	9	K-9	Measure dim. with telescope or small hole gage.	.0079
Plug Gauge		K-26	Use plug gauge under 2".	.0044
Gauge	10	K-27	Use plug gauge over 2".	.0057
Thread			Ring thd. gauge) see charts 1-a & 1-b	.0022 /
Gauges	11	K-18	Plug thd. gauge)	
Outside		K-30	Use spring caliper up to 8"	.0104
Calipers	12	K-33	Use firm joint calipers 8" to 24"	.0140
Inside		K-31	Use spring calipers up to 8"	.0109
Calipers	13	K-34	Use firm joint calipers 8" to 24"	.0180
Surface Gauge	14	K-44	Use surface gauge with indicator and gauge blocks.	.0159
Feeler Gauge	15	K-47	Use feeler gauge each point.	.0030
Radius Angle Profile	16	K-19	Use, Radius, Angle, or Profile Gauge.	.0045
Adjustable				
Parallels	17	K-21	Use adjustable parallels.	.0083
Electro				
Limit Gauge	18	K-48	Use electro limit gauge	.0092
Dial Bore	19	K-49	Use dial bore or Precisionaire gauge	.0065
Precisionaire				
Square or Protractor	20	K-23	Use square or protractor.	.0044
Comparator	21	K-51	Measure one dimension	.0470
	22	K-52	Each Additional Dimension	.0325

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CHART #2 - TRAVERSE GRIND
Recommended RPM Stock Removal Per Stroke
and Grinding Time Per Inch of Stroke

Bore Dia.	SPM	Avail RPM	Stock to be removed per stroke in inches			
			Hardened Steel, Corr. Res. Steel 30 SPM	Carbon and Alloy Steel 50 SPM	Brass, Bronze & Copper 75 SPM	Inch Stroke Time in Hours
1/4"	30-50-75	480	.0001	.0002	.0002	.00015
	30	325	.0001			.00020
3/8"	50-75	480		.0002	.0002	.00015
	30	240	.0001			.00025
1/2"	50	325		.0002		.00020
	75	480			.0002	.00015
5/8"	30	160	.0001			.00030
	50	325		.0002		.00020
	75	480			.0002	.00015
3/4"	30	160	.0002			.00030
to	50	240		.0002		.00025
7/8"	75	325			.0002	.00020
1"	30-50	160	.0002	.0002		.00030
	75	240			.0002	.00025
	30-50	160	.0002	.0002		.00030
1-1/4"	75	240			.0002	.00025
1-1/2"						
and over	30-50-75	160	.0002	.0002	.0002	.00030

It is recommended that additional strokes be allowed for the following:

A total dia. tolerance of .001 or less allow 8 strokes

A 63 RMS allow 4 strokes

A 32 RMS allow 8 strokes

A 16 RMS or better allow 12 strokes

NOTE: For a bore 3/8" dia. and under where the length is at least 2 times the dia. use 25% of the recommended stock removal per stroke, and 4 times the number of additional strokes.

For a bore 3/8" to 5/8" dia. where the length is at least 2 1/2 times the dia., use 33% of the recommended stock removal per stroke, and 3 times the number of additional strokes.

For a bore of over 5/8" dia. where the length is at least 4 times the dia., use 75% of the recommended stock removal per stroke, and 2 times the number of additional strokes.

Grind Time = L x N x T

Where L = Length of Stroke

Where N = Number of Strokes = $\frac{\text{(Stock to be removed)}}{\text{(Stock removal per stroke)}}$

Where T = Time in hours per one inch of stroke

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CHART #3 - Plunge Grind

Grinding Time For .001" Stock Removal

Hardened Steel and Corr. Res. Steel; Remove ".00007 Per Rev.
 Alloy Steel; Remove ".00010 Per Rev.
 Carbon Steel; Remove ".00010 Per Rev.
 Brass, Bronze and Copper; Remove ".00007 Per Rev.

Bore Dia.	SPM	Avail RPM	Time in Dec. Mins. to Remove ".001 Stock		
			Hardened Steel Corr. Res. Steel 30 SPM	Alloy & Carbon Steel 50 SPM	Brass, Bronze and Copper 75 SPM
3/8 & under	30	325	.0008		
	50-75	480		.0004	.0006
1/2"	30	240	.0010		
	50	325		.0005	
	75	480			.0006
5/8"	30	160	.0014		
	50	325		.0005	
	75	480			.0006
3/4" to 7/8"	30	160	.0014		
	50	240		.0007	
	75	325			.0007
1"	30-50	160	.0014	.0010	
1 1/4"	75	240			.0010
1 1/2"	30-50-75	160	.0018	.0013	.0015
1 3/4"	30-50-75	160	.0021	.0015	.0016
2"	30-50-75	160	.0024	.0018	.0017
2 1/4"	30-50-75	160	.0027	.0020	.0018
2 1/2"	30-50-75	160	.0030	.0022	.0021
2 3/4"	30-50-75	160	.0033	.0014	.0024
3"	30-50-75	160	.0036	.0026	.0027
Over 3"	30-50-75	160	.0040	.0030	.0030

NOTE: Allow the time for an additional .004" to cover the time required for Sparkout.

CHART #4

Hardened Steel, Corr. Res. Steel
All other Steel, & non-ferrous metals

It is recommended that time for 20 revolutions
required 30 revolutions where a 16 RMS or

Material	Average RPM	Time Per Rev.	.001	.002	.003	Stock to be removed
Hardened Steel	160	.00010	.0010	.0020	.0030	.004
	240	.00007	.0007	.0014	.0021	.003
Corr. Res. Steel	325	.00005	.0005	.0010	.0015	.002
	480	.00004	.0004	.0008	.0012	.002
All other Steel & Non ferrous metals	160	.00010	.0010	.0020	.0030	.004
	240	.00007	.0007	.0014	.0021	.003
	325	.00005	.0005	.0010	.0015	.002
	480	.00004	.0004	.0008	.0012	.002

Derivation of Chart 4. .016
RP

RPM = Revolutions per minute, .016

S = Amount of stock to be removed,

.0006 = W3 in Dec. Hours (Constant)

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GRIND TIME

Remove .0001" Per Rev.

Remove .0002" Per Rev.

Allowed for Sparkout where a 32 RMS is required.

removed in inches					
.006	.007	.008	.009	.010	.011
.0066	.0076	.0086	.0096	.0106	.0116
.0049	.0056	.0063	.0070	.0077	.0084
.0036	.0041	.0046	.0051	.0056	.0061
.0030	.0034	.0038	.0042	.0046	.0050
.0046	.0049	.0052	.0055	.0058	.0061
.0027	.0031	.0034	.0038	.0041	.0044
.0021	.0024	.0026	.0029	.0031	.0034
.0018	.0020	.0022	.0024	.0026	.0028

÷ .0006 = Allowed Time

minute in Dec. Hours

eed Per Revolution

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SECTION III

LIST OF CONSTANTS AND SYNTHESIS

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LIST OF CONSTANTS

"K"		<u>TMU</u>	<u>DEC.</u> <u>HOURS</u>
K-1	Initial and machine set-up	112015.3	1.1202
K-2	Set-up workhead guard	2727.0	.0273
K-3	Use one screw	626.6	.0063
K-4	Use each washer	100.8	.0010
K-5	Obtain tool from toolbox	647.4	.0065
K-6	Obtain and lay aside tool on bench	164.3	.0016
K-7	Obtain tools in cabinet	6610.8	.0661
K-8	Set-up surface gage and indicator	658.1	.0066
K-9	Use indicator	435.2	.0044
K-10	True-up object with indicator	1674.2	.0167
K-11	Set-up one table traverse or stop dog	436.6	.0044
K-12	Set-up one table barrel stop	743.2	.0074
K-13	Set-up one workhead barrel stop	1574.0	.0157
K-14	Additional set-up for each barrel stop	2022.1	.0202
K-15	Index table barrel stop one position	153.0	.0015
K-16	Index workhead barrel stop one position	387.7	.0039
K-17	Change grinding wheel	2643.7	.0264
K-18	Mount Wheelhead	4130.5	.0413
K-19	Change quill on wheelhead	2320.4	.0232
K-20	Set-up wheelhead	12676.0	.1268
K-21	Align wheelhead with shim	5310.7	.0531
K-22	Constant per piece	660.2	.0066
K-23	Dress wheel face by hand	129.3	.0013
K-24	Mount face plate	9667.2	.0967
K-25	Remove chuck, fixture or face plate	4992.7	.0499
K-26	Mount 3 jaws in chuck	12062.1	.1206
K-27	Set-up 3 jaw chuck	71859.0	.7186
K-28	Grind jaws	37042.4	.3704
K-29	Set-up coolant	1416.0	.0142
K-30	Set-up truing unit	12509.1	.1251
K-31	Align workhead	21382.7	.2138
K-32	Dress diameter of wheel with diamond	803.3	.0080
K-33	Set-up machine	57634.8	.5763
K-34	Set-up face plate	19652.6	.1965
K-35	Set-up fixture	21326.8	.2133
K-36	Assemble 3 chuck finger stops	14769.3	.1477
K-37	Set-up finger back stops in chuck	28412.9	.2841
K-38	Set-up radius dresser	32299.4	.3230
K-39	Dress radius of wheel with radius dresser	740.8	.0074
K-40	Use air chuck	304.9	.0030
K-41	Use spring chuck	365.3	.0037
K-42	Use magnetic chuck	2293.0	.0229
K-43	Handle part 5# and under	350.1	.0035
K-44	Handle part over 5#	500.1	.0050
K-45	Set up fixture on magnetic chuck	2559.4	.0256
K-46	Deburr sharp edge	172.7	.0017
K-47	Deburr each additional sharp edge	83.0	.0008
K-48	True-up part in fixture with adjusting screws	2142.6	.0214
K-49	Supervisor's first piece approval	11521.4	.1152

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K-50	Set-up workhead on extended bridge	16440.7	.1644
K-51	Set-up steadyrest on extended bridge	11387.7	.1139
K-52	Use steadyrest on extended bridge	365.2	.0037
K-53	Additional set-up for extended bridge	29654.3	.2965

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SYNTHESIS

		<u>TMU</u>	<u>Dec Hours</u>
K-1	Initial and machine set-up	112015.3	1.1202
A	Walk to supervisors desk or timekeeper & return 6387.2x2	12774.4	
B	Walk to tool crib and return	12637.2	
I	Study blueprint and operation sheet(average)	5000.0	
K-7	Obtain tools in cabinet	6610.8	
K-8	Set-up surface gage & indicator	658.1	
K-33	Set-up machine	57634.8	
	Time to clean machine	16700.0	
K-2	Set-up workhead guard	2727.0	.0273
A-4	Mount workhead guard	267.6	
B-4	Remove workhead guard	181.2	
K-6	Obtain and lay aside tool on bench 164.3x2	328.6	
H	Walk to rear of machine and return 397.2x2	794.4	
D-2	Tighten or loosen each screw with wrench 88.2x6	529.2	
K-3	Use one screw	626.0	
K-3	Use one screw	626.0	.0063
A-2	Move each screw to hole and engage	110.7	
B-2	Run down each screw by hand	162.1	
C-2	Run out each screw by hand and lay aside	176.8	
D-2	Tighten or loosen each screw with wrench 88.2x2	176.4	
K-4	Use each washer	100.8	.0010
E-2	Place each washer on stud	56.2	
F-2	Remove and lay aside each washer	44.6	
K-5	Obtain tools from tool box	647.4	.0065
N	Open and close toolbox drawer 57.4x3	172.2	
P	Get tool from toolbox and return 63.0x6	378.0	
Q	To workbench and back	97.2	
K-6	Obtain and lay aside tool on bench	164.3	.0016
Q	To workbench and back	97.2	
G-4	Pick up and lay aside tool	67.1	
K-7	Obtain tools in cabinet	6610.8	.0661
C	Walk to cabinet & return 2337.2x2	4674.4	
F	Obtain and replace tool in cabinet 99.0x6	594.0	
M	Open & close cabinet doors 85.7x4	342.8	
G-4	Pickup and lay aside tool 67.1x12	805.2	
Q	To workbench and back 97.2x2	194.4	
K-8	Set up surface gage and indicator	658.1	.0066
V	Assemble indicator to surface gage	432.5	
W	Disassemble indicator from surface gage	225.6	

		SYNTHESIS (Contd)	FORMULA GR-2 TMU	Dec Hours
K-9		Use indicator	435.2	.0044
Y		Read indicator	90.1	
S-3		Wipe small object off with cloth	110.0	
S-4		Move indicator to part	70.8	
K-6		Obtain and lay aside tool on bench	164.3	
K-10		True-up object with indicator	1674.2	.0167
K-9		Use indicator	435.2	
G-3		Tap object with hammer 102.3x3	306.9	
Y		Read indicator 90.1x2	180.2	
G-4		Pick up and lay aside tool	67.1	
T		Turn workhead spindle by hand 58.1x10	581.0	
S		Turn workhead spindle with "jog" button 34.6x3	103.8	
K-11		Set-up one table traverse or stop dog	436.6	.0044
J-2		Move one table traverse or stop dog	215.2	
L-2		Adjust one table traverse or stop dog 73.8x3	221.4	
K-12		Set-up one table barrel stop	743.2	.0074
K-11		Set-up one table stop dog	436.6	
F-3		Move table by hand 153.3x2	306.6	
K-13		Set-up one workhead barrel stop	1574.0	.0157
D-2		Tighten or loosen each nut with wrench 88.2x4	352.8	
J-4		Move workhead barrel stop unit to or from indicator 38.3x2	76.6	
G-4		Pick-up and lay aside tool 67.1x3	201.3	
H-2		Index barrel stop one position	153.0	
K-6		Obtain and lay aside tool on bench	164.3	
K-3		Use one screw	626.0	
K-14		Additional set-up for each barrel stop	2022.1	.0202
F-3		Move table by hand 153.3x2	306.6	
H-2		Index barrel stop one position	153.0	
G-4		Pick-up and lay aside tool	67.1	
K-5		Obtain tools from toolbox	647.4	
K-3		Use one screw	626.6	
L-2		Adjust one table stop dog (Sim.Mot.Pat.) 73.8x3	221.4	
K-15		Index table barrel stop one position	153.0	.0015
H-2		Index barrel stop one position	153.0	
K-16		Index workhead barrel stop one position	387.7	.0039
H-2		Index barrel stop position	153.0	
M-3		Move workhead cross slide	148.2	
N-3		Move workhead cross slide to dial reading	86.5	

FORMULA GR-2

SYNTHESIS (Cont'd)		TMU	Sec. Hours
K-17	Change grinding wheel	2643.7	.0264
Y2	Mount & remove grinding wheel	239.4	
T-3	Dress diameter of wheel with carborundum "stick"	451.4	
K-3	Use one screw	626.6	
K-6	Obtain & lay aside tool on bench	164.3	
G-4	Pickup and lay aside tool 67.1x2	134.2	
U-3	Set stop on wheelhead cross slide hardwheel	224.5	
K-32	Dress diameter of wheel with diamond	803.3	
K-18	Mount wheelhead	4130.5	.0413
U-2	Mount and remove wheelhead	413.6	
Z-2	Mount and remove wheelhead drive belt	208.4	
A-3	Tighten and loosen wheelhead drive belt	140.8	
D-3	Raise and lower grinding wheel guard by hand	318.0	
S-3	Wipe large object off with cloth 163.4x2	326.8	
Q-3	Tap object with hammer 102.3x2	204.6	
G-4	Pick up and lay aside tool 67.1x3	201.3	
D-2	Tighten or loosen each screw or nut with wrench 88.2x6	529.2	
U	Adjust length of wheel guard	41.7	
K-6	Obtain and lay aside tool on bench 164.3x3	492.9	
K-3	Use one screw 626.6x2	1253.2	
K-19	Change quill on wheelhead	2320.4	.0232
X-2	Block wheelhead spindle 212.3x2	424.6	
K-3	Mount & remove quill (Sim.Mot.Pat.)	626.6	
K-6	Obtain and lay aside tool on bench 164.3x2	328.6	
G-4	Pick up and lay aside tool 67.1x6	402.6	
D-3	Raise and lower wheelhead drive guard (S.M.P)	318.0	
S-3	Wipe small object with cloth 110.0x2	220.0	
K-20	Set-up wheelhead	12676.0	.1268
D	Walk to wheelhead storage rack & return	3237.2	
E	Obtain and replace wheelhead at storage rack	344.2	
K-17	Change grinding wheel	2643.7	
K-18	Mount wheelhead	4130.5	
K-19	Change quill on wheelhead	2320.4	
K-21	Align wheelhead with shim	5310.7	.0531
V-2	Place shim under wheelhead 118.1x2	236.2	
W-2	Remove shim from under wheelhead 89.8x2	179.6	
D-2	Tighten or loosen each screw with wrench 88.2x8	705.6	
K-22	Operate machine each dimension 660.2x3	1980.6	
W-3	Bring grinding wheel to face of work with facing attachment 62.7x3	188.1	
	Use 6" scale - Formula GA-1 (K-2) 250.0x3	750.0	
	Clean-up grind the face est. 150.0x3	450.0	
K-23	Dress wheel face by hand 129.3x3	387.9	
G-4	Pick up and lay aside tool 67.1x4	268.4	
K-6	Obtain and lay aside tool on bench	164.3	

FORMULA GR-2

SYNTHESIS (Cont'd)			<u>TMU</u>	<u>Dec. Hours</u>
K-22	Constant per piece		660.2	.0066
W-1	Set table traverse speed	54.6x2	109.2	
E-3	Reverse table traverse by hand	35.2x2	70.4	
L-3	Move wheelhead cross slide	90.3x2	180.6	
	Hydraulic table traverse time (est)		300.0	
K-23	Dress wheel face by hand		129.3	.0013
Y-3	Dress face of grinding wheel with carborundum "stick"		129.3	
K-24	Mount face plate, chuck or fixture		9667.2	.0967
G-2	Lock and unlock workhead spindle	71.2x4	284.8	
S-3	Wipe object off with cloth	163.4x2	326.8	
R-3	Blow off part with air	117.4x12	1408.8	
Z-3	Obtain and lay aside chuck removing board		397.8	
L-1	Put chuck, fixture or face plate on spindle nose		156.1	
P-4	Place bolt in chuck, fixture or face plate & run in	414.0x6	2484.0	
R-4	Tighten bolt in chuck, fixture or face plate with wrench	211.9x12	2542.8	
E-2	Place each washer on bolt	56.2x6	337.2	
G-4	Pick up and lay aside tool	67.1x6	402.6	
T	Turn workhead spindle by hand	58.1x20	1162.0	
K-6	Obtain and lay aside on bench		164.3	
K-25	Remove chuck, fixture or face plate		4992.7	.0499
M-1	Remove chuck, fixture or face plate from spindle nose		95.8	
G-2	Lock and unlock workhead spindle	71.2x2	142.4	
R-4	Loosen bolt in chuck, fixture or face plate with wrench	211.9x6	1271.4	
Q-4	Run out bolt in chuck, fixture or face plate and lay aside	322.9x6	1937.4	
Z-3	Obtain and lay aside chuck removing board		397.8	
K-6	Obtain and lay aside tool on bench		164.3	
T	Turn workhead spindle by hand	58.1x10	581.0	
G-4	Pick up and lay aside tool	67.1x6	402.6	
K-26	Mount 3 jaws in chuck		12062.1	.1206
D-1	Mount and remove one chuck jaw	75.6x3	226.8	
T	Turn workhead spindle by hand	58.1x12	697.2	
S-2	Wipe small object off with cloth	110.0x9	990.0	
K-3	Use one screw	626.6x12	7519.2	
G-1	Grease one jaw in 3 jaw chuck	125.5x3	376.5	
R-1	Open and close chuck jaws	123.4x3	370.2	
K-6	Obtain and lay aside tool on bench	164.3x3	492.9	
E-4	Additional to tighten and loosen screw with allen wrench	132.0x9	1188.0	
G-4	Pick up and lay aside tool	67.1x3	201.3	

FORMULA GR-2

		SYNTHESIS (Cont'd)	TMU	Dec Hours
K-27		Set-up 3 jaw chuck	71859.0	.7186
K-24		Mount chuck	9667.2	
K-26		Mount 3 jaws in chuck	12062.1	
K-28		Grind jaws	37042.4	
Q-1		Set pressure of chuck	411.3	
K-20		Set-up wheelhead	12676.0	
K-28		Grind jaws	37042.4	.3704
H-1		Place spider in chuck and remove	354.8x6	2128.8
R-1		Open and close chuck jaws	123.4x9	1110.6
K-22		Coolant per piece (S.M.P.)	660.2x8	5281.6
		Check dia. of jaws (GAU-1(K-26))	440.0x8	3520.0
		Grind jaw time (average) Est		16700.0
U-4		Stone sharp edges of 3 jaws		1262.4
T		Turn workhead spindle by hand	58.1x3	174.3
K-32		Dress dia. of wheel with diamond	803.3x5	4016.5
L-2		Adjust spider to size (S.M.P.)	73.8x6	442.8
K-41		Place part in chuck (S.M.P.)	365.3x2	730.6
U-1		Obtain and lay aside part	116.4x2	232.8
K-9		Use indicator	435.2x2	870.4
Y		Read indicator	90.1x2	180.2
S-4		Move indicator to part	70.1x2	141.6
V-3		Wipe off holding surface of 3 jaw chuck 58".8x2		117.6
T-1		Place and remove part from 3 jaw chuck 66".1x2		132.2
K-29		Set-up coolant	1416.0	.0142
Z		Position coolant pipe	78.7x2	157.4
A-1		Adjust coolant flow	131.2x2	262.4
G		Walk to side of machine and return	294.2x2	588.4
G-4		Pick up and lay aside tool		67.1
D-2		Tighten or loosen each nut with wrench 88.2x2		176.4
K-6		Obtain and lay aside tool on bench		164.3
K-30		Set-up truing unit	12509.1	.1251
N-2		Insert and remove diamond in holder		102.8
P-2		Set truing unit for automatic diamond rise		309.9
			103.3x3	
R-2		Move truing unit forward or back	113.1x2	226.2
S-2		Move truing unit base		216.4
D-2		Tighten or loosen each nut with wrench 88.2x32		2822.4
S-3		Wipe small object off with cloth	110.0x2	220.0
H		Walk to rear of machine and back	397.2x7	2780.4
K-22		Operate machine each dimension	660.2x6	3961.2
K-6		Obtain and lay aside tool on bench	164.3x3	492.9
G-4		Pick-up and lay aside tool	67.1x6	402.6
K-3		Use one screw		626.6

FORMULA GR-2

SYNTHESIS (Cont'd)		TMU	Dec Hours
K-31	Align workhead	21382.7	.2138
C-3	Swivel workhead to adjust taper of work	117.4x4 469.6	
K-32	Dress diameter of wheel with diamond	803.3x5 4016.5	
G-4	Pickup and lay aside tool	67.1x5 335.5	
D-2	Tighten or loosen each nut with wrench	88.2x32 2822.4	
B-3	Swivel work 1/2" taper per foot		296.6
H	Walk to rear of machine and return	397.2x5 1986.0	
K-9	Use indicator	435.2x4 1740.8	
K-22	Operate machine each dimension	660.2x5 3301.0	
K-6	Obtain and lay aside tool on bench		164.3
	Clean-up grind time average (est)	600.0x5 3000.0	
	Check taper with gage (GAU-1(K-49))	650.0x5 3250.0	
K-32	Dress diameter of wheel with diamond	803.3	.0080
E-3	Reverse table travel by hand	35.2x3 105.6	
L-3	Move wheelhead cross slide	90.3x2 180.6	
T-2	Lower truing diamond by hand		57.9
W-1	Set table traverse speed	54.6x2 109.2	
	Wheel dress time (average) est.		350.0
K-33	Set-up machine	57634.8	.5763
K-20	Set-up wheelhead	12676.0	
K-31	Align workhead	21382.7	
K-29	Set-up coolant	1416.0	
K-30	Set-up truing unit	12509.1	
G	Walk to side of machine and return	7451.6	
J	Turn master switch on or off	90.2x2 180.4	
H	Walk to rear of machine and return	397.2x2 694.4	
H-3	Mount & remove front or rear splash guard	204.7x2 409.4	
R	Turn wheelhead or hydraulic motor on or off	112.7x4 450.8	
P-3	Open or close air supply for hose	159.8x2 319.6	
Y-1	Set workhead spindle speed	144.8 144.8	
K-34	Set-up face plate	19652.6	.1965
K-24	Mount face plate	9667.2	
K-25	Remove chuck, fixture or face plate	4992.7x2 9985.4	
K-35	Set-up fixture	21326.8	.2133
K-34	Set-up fixture (S.M.P.)	19652.6	
K-10	True-up object with indicator	1674.2	

FORMULA GR-2

SYNTHESIS		TMU	Dec Hours
K-36	Assemble (3) chuck finger stops	14769.3	.1477
E-1	Walk to vise and return	1537.2	
	Use vise- (Form. F-2(K-8)	243.5x6	1461.0
K-3	Use one screw	626.6x3	1879.8
	Use 6" scale- (Form GAU-1(K-2)	250.0x6	1500.0
D-2	Tighten or loosen each screw	88.2x6	529.2
G-4	Pick up and lay aside tool	67.1x9	603.9
K-5	Obtain tools from tool box		647.4
K-7	Obtain tools in cabinet		6610.8
K-37	Set-up finger back stops in chuck	28412.9	.2841
K-36	Assemble (3) chuck finger stops	14769.3	
	Use 6" scale (For. GAU-1 (K-2)	250.0	
S-3	Wipe large object off with cloth 163.4x3	490.2	
S-3	Wipe small object off with cloth 110.0x3	330.0	
F-1	Mount one finger back stop 1204.2x3	3612.6	
J-1	Reposition one finger back stop 54.2x6	325.2	
T-4	Remove one finger back stop 306.9x3	920.7	
K-6	Obtain and lay aside tool on bench 164.3x2	328.6	
T	Turn workhead spindle by hand 58.1x12	697.2	
G-4	Pick up and lay aside tool 67.1x3	201.3	
K-22	Operate machine each dimension	660.2	
R	Turn wheelhead motor on or off 112.7x2	225.4	
	Wait for wheelhead to stop EST	700.0	
S	Turn workhead spindle on or off with turn button 34.6x4	138.4	
F-3	Move table by hand	153.3	
E-4	Additional to tighten and loosen screw with allen wrench 132.0x3	396.0	
K-3	Use one screw 626.6x3	1879.8	
R-1	Open and close chuck jaws 123.4x2	246.8	
	Clean up grind fingers of stops EST	1700.0	
K-23	Dress wheel face by hand 129.3x3	387.9	
K-38	Set up radius dresser	32299.4	.3230
C-4	Remove and replace diamond holder unit	86.2	
D-4	Mount and remove radius dresser	88.2	
K-39	Dress radius of wheel with radius dresser 740.8x10	7408.0	
F-4	Set radius on radius dresser 38.5x10	385.0	
K-3	Use one screw 626.6x8	5012.8	
G-4	Pick up and lay aside tool 67.1x20	1342.0	

FORMULA GR-2

SYNTHESIS (Cont'd)		TMU	Dec Hours
K-38	(Cont'd)		
D-2	Tighten or loosen each screw with wrench		
	88.2x11	970.2	
K-6	Obtain and lay aside tool on bench	164.3x11	1807.3
J-3	Move wheelhead cross slide	163.3x4	653.2
U-3	Set stop on wheelhead cross slide handwheel		224.5
S-3	Wipe small object off with cloth	110.0x2	220.0
K-22	Operate machine each dimension	660.2x10	6602.0
	Clean up grind (average) EST	300.0x10	3000.0
	Use radius gauge GAU-1 (K-24)	450.0x10	4500.0
K-39	Dress radius of wheel with radius dresser	750.8	.0074
L	Move wheelhead cross slide	90.3x2	180.6
T-2	Raise or lower truing diamond by hand	57.9x2	115.8
E-3	Reverse table travel by hand		35.2
W-1	Set table traverse speed	54.6x2	109.2
	Dress time (average) EST		300.0
K-40	Use air chuck	304.9	.0030
S-1	Open and close chuck jaws (air)		63.0
T-1	Place and remove part from 3 jaw chuck		66.1
V-3	Wipe off holding surface of 3 jaw chuck		58.8
R-3	Blow off part with air		117.0
K-41	Use spring chuck	365.3	.0037
R-1	Open and close chuck jaws (spring)		123.4
T-1	Place and remove part from 3 jaw chuck		66.1
V-3	Wipe off holding surface of 3 jaw chuck		58.8
R-3	Blow off part with air		117.0
K-42	Use magnetic chuck	2293.0	.0229
K-10	True-up object with indicator		1674.2
C-1	Turn chuck magnet on and off		211.8
M-4	Mount and remove part or fixture from magnetic chuck		80.2
S-3	Wipe large object off with cloth	163.4x2	326.8
K-43	Handle part 5# and under	350.1	.0035
U-1	Lay aside and obtain new part		116.4
R-3	Blow off part (air)		117.0
G-3	Raise and lower workhead guard		116.7
K-44	Handle part over 5#	500.1	.0050
H-4	Lay aside and obtain new part		266.4
R-3	Blow off part (air)		117.0
G-3	Raise and lower workhead guard		116.7

FORMULA GR-2

SYNTHESIS
(Cont'd)

		<u>TMU</u>	<u>Dec. Hours</u>
K-45	Set-up fixture on magnetic chuck	2559.4	.0256
K-42	Use magnetic chuck	2293.0	
H-4	Lay aside and obtain new part (Sim.Mot.Pat)	266.4	
K-46	Deburr sharp edge	172.7	.0017
N-4	Deburr sharp edge with stone	172.7	
K-47	Deburr each additional sharp edge	83.0	.0008
N-4	Deburr each additional sharp edge with stone	83.0	
K-48	Free-up part in fixture with adjusting screws	4450.8	.0445
K-9	Use indicator	435.2	
S	Turn workhead spindle with job button		
	34.6x2	69.2	
T	Turn workhead spindle by hand	58.1x6	348.6
Y	Read indicator	90.1x6	540.6
V-4	Tighten and loosen thumb screw hand tight		
	107.0x7	749.0	
K-49	Supervisor's first piece approval	11521.4	.1152
A	Walk to supervisor's desk and return (without instructions)	1387.2	
G-4	Pick up and lay aside blue print or piece part 67.1x2	134.2	
L	Time for supervisor to study blueprint and operation sheet	5000.0	
GAU-1	Time to check each dimension (average)		
	1000.0x5	5000.0	
K-50	Set-up workhead on extended bridge	16440.6	.1644
X-4	Move workhead on extended bridge 36" (aver.)		
	1222.7x2	2445.4	
K-6	Obtain and lay aside tool on bench		
	164.3x4	657.2	
D-2	Tighten or loosen each nut with wrench		
	88.2x32	2822.4	
V-4	Tighten or loosen nut by hand (S.M.P.)		
	107.0x32	3424.0	
G-4	Pickup and lay aside tool	67.1x12	805.2
S-3	Wipe object of with cloth Large object	1307.2	
	163.4x8		
R-4	Tighten or loosen nut on workhead (S.M.P.)		
	211.9x16	3390.4	
H	Walk to rear of machine & return	397.2x4	1588.8

FORMULA GR-2

SYNTHESIS
(Cont'd)

		<u>TMU</u>	<u>Dec. Hours</u>
K-51	Set-up steadyrest on extended bridge	11387.7	.1139
Y-4	Mount steadyrest on bridge & remove	700.0	
K-6	Obtain and lay aside tool on bench 164.3x4	657.2	
D-2	Tighten or loosen each nut with wrench 88.2x30	2646.0	
V-4	Tighten or loosen nut by hand (S.M.P.) 107.0x4	428.0	
G-4	Pickup and layaside tool 67.1x5	335.5	
S-3	Wipe large object off with cloth 163.4x2	326.8	
R-3	Blow off part with air 117.0x2	234.0	
R-4	Tighten or loosen nut on steadyrest (S.M.P.) 211.9x4	847.6	
Z-4	Set one steadyrest jaw to part 406.0x3	1218.0	
A-5	Adjust one steadyrest jaw to part 268.9x10	2689.0	
K-9	Use indicator 435.2x3	1305.6	
K-52	Use steadyrest on extended bridge	365.2	.0037
W-4	Close & open steadyrest on extended bridge	365.2	
K-53	Additional set-up for extended bridge	29654.3	.2965
K-50	Set-up work head	16440.6	
K-51	Set-up steadyrest	11387.7	
K-52	Use steadyrest 365.2x5	1826.0	

FORMULA CR-2

SECTION IV

TABLE OF ELEMENTS AND METHODS ANALYSIS SHEETS

ORIGINAL COPY WAS OF POOR QUALITY.
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FORMULA OR-2

TABLE OF ELEMENTS

	TIME
A Walk to supervisor's desk or timekeeper and return	6387.2
B Walk to tool crib and return	12637.2
C Walk to cabinet and return	2337.2
D Walk to wheelhead storage rack and return	3237.2
E Extract and replace wheelhead at storage rack	344.2
F Extract and replace tool in cabinet	99.0
G Walk to side of machine and return	294.2
H Walk to rear of machine and return	39.2
J Turn master switch on or off	90.2
L Study blueprint and operation sheet	5000.0
M Open and close cabinet doors	85.7
N Open and close tool box drawer	57.4
P Get tool from tool box and replace	63.0
Q To work bench and back	97.2
R Turn wheelhead, hydraulic or coolant motor on or off	112.7
S Turn workhead spindle with jog button	34.6
T Turn workhead spindle 1/4 turn by hand	58.1
U Adjust length of wheel guard	41.7
V Assemble indicator to surface gage	432.5
W Disassemble indicator from surface gage	225.6
X Set indicator to object	124.3
Y Read indicator	70.1
Z Position coolant pipe	78.7
A-1 Adjust coolant flow	131.2
B-1 Turn chuck magnet on and off (electro magnet)	125.8
C-1 Turn chuck magnet on and off (permanent magnet)	211.8
D-1 Mount and remove one chuck jaw	75.6
E-1 Walk to vise and return	1537.2
F-1 Mount one finger, back stop in chuck	1204.2
G-1 Grease one jaw of the 3 jaw chuck	125.5
H-1 Place spider in 3 jaw chuck and remove	354.2
J-1 Reposition in back stop in chuck	54.2
L-1 Put chuck fixture or face plate on spindle nose	156.1
M-1 Remove chuck, fixture or face plate from spindle nose	95.8
N-1 Open or close air chuck valve	165.0
P-1 Set air chuck pressure	144.1
Q-1 Set pressure of spring chuck	411.3
R-1 Oper and close chuck jaws - spring chuck	123.4
S-1 Open and close chuck jaws - air chuck	63.0
T-1 Place and remove part from 3 jaw chuck	66.1
U-1 Lay aside and obtain new part - 5# and under	116.4
V-1 Set workhead spindle speed	144.8
W-1 Set table traverse speed - hydraulic	54.6
X-1 Run down each nut by hand	79.2

FORMULA GR-2

TABLE OF ELEMENTS
(continued)

	(continued)	TIME
A-2	Move each screw to hole and engage	110.7
B-2	Run down each screw by hand	102.1
C-2	Run out each screw by hand and lay aside	176.8
D-2	Tighten or loosen each screw or nut with wrench	60.2
E-2	Place each washer on stud	96.2
F-2	Remove and lay aside each washer	44.6
G-2	Lock and unlock workhead spindle	71.2
H-2	Index barrel stop one position	133.0
J-2	Move one table reverse or stop dog 6"	217.2
L-2	Adjust one table reverse or stop dog	73.8
M-2	Raise or lower stop dog tongue	64.3
N-2	Insert and remove diamond in holder	102.0
P-2	Set truing unit for automatic diamond rise	115.9
Q-2	Set trip for automatic diamond rise	103.3
R-2	Move truing unit forward or back 3"	113.1
S-2	Move truing unit base 3"	216.4
T-2	Raise or lower truing diamond by hand	37.9
U-2	Mount and remove wheelhead	413.6
V-2	Place shim under wheelhead	110.1
W-2	Remove shim from under wheelhead	80.0
X-2	Block wheelhead spindle to remove and mount quill	212.3
Y-2	Mount and remove grinding wheel on quill	230.4
Z-2	Mount and remove wheelhead drive belt	200.4
A-3	Tighten and loosen wheelhead drive belt	140.0
B-3	Swivel workhead for 1/2" taper per foot	206.6
C-3	Swivel workhead to adjust taper or align load	117.4
D-3	Raise and lower grinding wheel guard by hand	310.0
E-3	Reverse table traverse by hand	30.2
F-3	Move table by hand one-half inch	153.3
G-3	Raise and lower workhead guard	110.7
H-3	Mount and remove front or rear splash guard	204.7
J-3	Move wheelhead cross slide (Set up)	163.3
L-3	Move wheelhead cross slide (operation)	90.3
M-3	Move workhead cross slide one half inch	140.2
N-3	Move workhead cross slide to dial reading	86.5
P-3	Open or close air supply for hose	159.0
Q-3	Tap object with hammer	102.3
R-3	Blow off part (air)	117.0
S-3	Wipe object off with cloth (Case I Small object)	110.0
	(Case II Large object)	163.4
T-3	Dress diameter of wheel with carborundum "stick"	451.4
U-3	Set stop on wheel head cross slide hand wheel	224.5
V-3	Wipe off bolting surface of 3 jaws	58.8
W-3	Bring grinding wheel to face of work with facing attachment	62.7
X-3	Dress face of grinding wheel with carborundum "stick"	267.2
	on wheel	
Y-3	Dress face of grinding wheel with carborundum "stick"	129.3
	(operation)	
Z-3	Obtain and adjust table reversing belt	397.8

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FORMULA GR-2

TABLE OF ELEMENTS

		<u>TIME</u>
A-4	Mount workhead guard	267.6
B-4	Remove workhead guard	181.2
C-4	Remove and replace diamond holder unit	86.2
D-4	Mount and remove radius dresser	88.2
E-4	Additional to tighten and loosen screw with Allen wrench	132.0
F-4	Set radius on radius dresser	38.5
G-4	Pick up and lay aside tool	67.1
H-4	Lay aside and obtain new part (over 5¢)	266.4
J-4	Move workhead barrel stop unit to or from indicator	38.3
M-4	Mount and remove part or fixture on magnetic chuck	80.2
N-4	Deburr sharp edge with stone	172.7
	Each additional sharp edge	83.0
P-4	Place bolt in chuck, fixture or face plate and run in	414.0
Q-4	Run out bolt in chuck, fixture or face plate and lay aside	322.9
R-4	Tighten or loosen bolt in chuck, fixture or face plate with wrench	211.9
S-4	Move indicator to part	70.8
T-4	Remove one finger back stop in chuck	306.9
U-4	Stone sharp edges of 3 jaws	1262.4
V-4	Tighten and loosen thumb screw hand tight	107.0
W-4	Close & Open extended bridge steadyrest	365.2
X-4	Move workhead on extended bridge 36"(average)	1222.7
Y-4	Mount steadyrest on extended bridge & remove	700.0
Z-4	Set one steadyrest jaw to part	406.0
A-5	Adjust one steadyrest jaw to part	268.9

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.N.	TNU	R.H.	No.	Description Right Ha
A Walk to supervisor's desk or timekeeper and return						
		18.6	TBC1			
		675.0	W45P			To supervisor
		5000.0	EST			Receive instructions
		18.6	TBC1			
		675.0	W45P			Return
		<u>6387.2</u>				
Without instructions		1387.2				
B Walk to tool crib and return						
		18.6	TBC1			
		2100.0	W140P			To tool crib
		8400.0	EST			Wait for service
		18.6	TBC1			
		2100.0	W140P			return
		<u>12637.2</u>				
C Walk to cabinet and return						
		18.6	TBC1			
		300.0	W20P			To cabinet
		1700.0	EST			Search & select
		18.6	TBC1			
		300.0	W20P			Return
		<u>2337.2</u>				
D Walk to wheelhead storage rack and return						
		18.6	TBC1			
		750.0	W50P			To storage area
		1700.0	EST			Search & select
		18.6	TBC1			
		750.0	W50P			Return to machine
		<u>3237.2</u>				
E Obtain & replace wheelhead at storage rack						
		29.0	B			
		14.4	143			Wheelhead
		2.0	GTA			
		27.8	M1402			Remove
		3.9	AB			
		37.2	TBC1			
		27.8	M14825			Lay on cart
		2.0	RL1			
		<u>172.7</u>				
Replace		172.7				

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	T.W.	R.H.	No.	Description-Left Hand
F Obtain and replace tool in cabinet			74.4	R28B		To tool
			2.0	G1A		
			<u>23.1</u>	M28B		Tool from cabinet
			49.5			
Replace			<u>49.5</u>			
			99.0			
G Walk to side of machine and return			18.6	TBC1		
			135.0	W9P		To side of machine
			18.6	TBC1		
			<u>135.0</u>	W9P		Return
			294.2			
H Walk to rear of machine and return			18.6	TBC1		
			180.0	W12P		To rear of machine
			18.6	TBC1		
			<u>180.0</u>	W12P		Return
			397.2			
J Turn master switches on or off						
To switch	B		29.0			
	G1A		2.0			
Open or close	M3A		4.9			
	RL1		2.0			
To 2nd switch	R10B		11.5			
	G1A		2.0			
Open or close	M3A		4.9			
	RL1		2.0			
	AB		<u>31.9</u>			
			90.2			
L Study blueprint and operation sheet			5000.0	EST		
M Open and close cabinet doors			8.7	R10A		To door handle
			2.0	G1A		
Same motion pattern			23.1	M28B		Open door
			2.0	RL1		
			24.4	R28B		To door
			.0	G5		
			25.5	M28A		Close door
			<u>.0</u>	RL2		
			85.7			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	THU	R.H.	No.	Description-Right Hand
N Open and close tool box drawer						
			15.8	R16B		To drawer
			2.0	G1A		
			8.9	M6B		Open
			2.0	RL1		
			6.4	M4B		To drawer
Same motion pattern			.0	G5		
			8.1	M6A		Close
			.0	RL2		
			14.2	R16E		To balance
			<u>57.4</u>			
P Get tool from tool box and replace						
			12.9	R12B		To tool
			9.1	G4B		
			13.4	M12B		Tool to body
			15.2	M12C		Tool to drawer
			10.4	P1NBE		Lay in drawer
			2.0	RL1		
			<u>63.0</u>			
Q To work bench and back						
			18.6	TBC1		To bench
			30.0	W2P		
			18.6	TBC1		To machine
			30.0	W2P		
			<u>97.2</u>			
R Turn wheel head, hydraulic or coolant motor on or off						
		SS18C1	20.6			
To button		B	29.0			
		R16E				
		G5	.0			
Push button		AP2	10.6			
		RL2	.0			
		AB	31.9			
To balance		SS18C1	<u>20.6</u>			
			127.7			
S Turn workhead spindle with jog button						
To jog button		R18D	18.4			
		G5	.0			
Push button		AP1	16.2			
		RL2	<u>.0</u>			
			34.6			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.N.	TNU	R.N.	No.	Description-Right Hand
T Turn workhead spindle one-quarter turn by hand						
To spindle		R24B	21.5			
		G1A	2.0			
Turn spindle		M12C10	20.8			
		RL1	2.0			
To balance		R12E	11.8			
			<u>58.1</u>			
U Adjust length of wheel guard						
			12.9	R12B		To guard
			2.0	G1A		
			8.0	MFC	4	Lengthen or shorten
			16.8	G2	3	
			2.0	RL1		
			<u>41.7</u>			
V Assemble indicator to surface gage						
To surface gage		R16B	15.8			
		G1A	2.0			
Gage to work area		M16B	15.8			
		G2	5.6			
			11.5	R10B		To surface gage arm
			2.0	G1A		
Hold surface gage base	AP1		16.2			
			11.8	M8C		Swing arm up
			2.0	RL1		
			11.5	R8D		To indicator holder screw
			2.0	G1A		
			16.2	AP1		
			8.0	M8B	4	Loosen screw
			22.4	G2	4	
		RL1	2.0	RL1		
To indicator		R16B	15.8			
		G1A	2.0			
To work area		M16B	15.8			
Hold		G2	5.6			
			11.5	R8D		To indicator arm lock screw
			2.0	G1A		
			16.2	AP1		
			4.0	M8B	2	Loosen lock screw
			11.2	G2	2	
			8.0	M8C		Swing indicator arm
			11.2	G2	2	
			4.0	M8B	2	Tighten lock screw
			16.2	AP1		
To indicator holder		RL1	2.0			
		R8D	11.5			
		G1A	2.0			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.N.	No.	Description-Right Hand
V (continued)						
Align holes in holder	{ 2	AP1	32.4			
		MFC	2.0			
			13.5	M10C		To indicator holder
			21.8	P2BD		
			3.4	M1C		Into holder
Tighten indicator holder	{ 4		5.2	M2C		Swing to position
		G2	5.6			
		MFB	8.0			
		G2	22.4			
		AP1	32.4			
		RL1	2.0			
			432.5			
W Disassemble indicator from surface gage						
To indicator holder		R16B	15.8	R16B		To indicator
			2.0	G1A		
Loosen screw	{ 4	AP1	16.2			
		MFB	8.0			
		G2	22.4			
			7.5	D2E	{	Remove indicator arm
			16.9	M4B		
		RL1	2.0			
To indicator		M4B	6.4			
		G1A	2.0			
			5.6	G2		
			16.2	AP1	{	Loosen indicator
			2.9	M1B		
			2.0	RL1		
			4.0	R2B	{	Swing Indicator arm
			2.0	G1A		
			4.6	M2B		
	G2		5.6			
			2.0	RL1		
			4.0	R2B		To screw
			2.0	C.A	{	Tighten screw
			2.9	M1B		
			16.1	AP1		
	RL1		2.0			
			15.8	M16B		Lay indicator aside
			2.0	RL1		
To surface gage base		R16B	15.8	R16B		To surface gage arm
		G1A	2.0	G1A		
Hold		AP1	16.2			
			10.6	M5B		Fold arm
		RL1	2.0	RL1		
			225.6			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
X Set indicator to object						
Set indicator on table and hold M12C	15.2					
	8.6	R6B				To surface gage arm
	2.0	G1A				
	11.8	M8C				Swing down
	2.0	RL1				
	10.1	R6D				To indicator
	2.0	G1A				
	16.2	P2SE				Align indicator to object
	2.0	RL1				
	5.9	R2D				To dial
	7.3	G1C1				} Turn dial to line
	5.2	M2C				
	16.2	P2SE				
	7.3	EF				
	2.0	RL1				
	10.5	R1OE				
	124.3					
Y Read indicator						
	29.2	EF			4	Read indicator
	60.0	EST				
Z Position coolant pipe						
	12.2	R12B				To pipe
	2.0	G1A				
	16.2	A11				
	12.0	M1L			6	} Move pipe
	33.6				6	
	2.0	R1				
	78.7					

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
A-1 Adjust collant flow						
			15.8	R16B		Valve
			2.0	G1A		
			32.4	AP1	2	} Increase or decrease flow
			4.0	M1C	2	
			75.0	EST		Flow time
			2.0	RL1		
			<u>131.2</u>			
B-1 Turn chuck magnet on and off (electro magnet)						
To switch		R24B	21.5			
		G1A	2.0			
Turn on		M3A	4.9			
		RL1	2.0			
To balance		R24E	19.2			
To switch		R24B	21.5			
		G1A	2.0			
Turn off	3	M3C	20.1			
	2	M3B	11.4			
		RL1	2.0			
To balance		R24E	<u>19.2</u>			
			125.8			
C-1 Turn chuck magnet on and off (permanent magnet)						
			15.7	M16C		Wrench to chuck
			5.6	F1SE		
			19.7	P2SSE		Wrench in socket
			5.6	G2		
			9.0	M2B10		} Turn on
			2.0	RL1		
			8.4	R4D		
			2.0	G1A		
			11.6	M4B10		
			7.5	D2E		Remove wrench
			<u>15.8</u>	M16B		To body
			105.9			
Turn off			<u>105.9</u>			
			211.8			
D-1 Mount and remove one chuck jaw						
			12.9	F12B		To jaw
			2.0	G1A		
			17.6	M18A		Jaw to chuck
			2.5	M1A		Align jaw
			3.4	M1C		
			16.2	P2SE		Position holes
			2.0	RL1		
			17.0	M18B		Remove and lay aside
			<u>2.0</u>	RL1		
			75.6			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
E-1 Walk to vise and return						
			18.6	TBC1		
			750.0	W50P		To vise
			18.6	TBC1		
			750.0	W50P		Return
			1537.2			
F-1 Mount one finger stop in chuck						
To screw		R16B	15.8	R16B		To stop
		G1A	2.0	G1A		
Screw to stop		M8C	11.8			
Screw through	{	P1SE	5.6			
Stop		M2A	3.6			
		RL1	2.0			
			18.7	M16C		Stop to chuck
			750.0	EST		Time for positioning in obstructed area
To stop		R16D	17.0			
Hold		G1A	2.0			
			2.0	RL1		
			15.8	R16B		To wrench
			2.0	G1A		
			18.7	M16C		Wrench to screw
			25.3	P2SSD		
			5.6	G2		Hold
		RL1	2.0			
To nut		R16B	15.8			
		G1A	2.0			
Nut to chuck		M14C	16.9			
	{	G2	16.8			
Nut to screw		M1C	6.0			
		P2SD	21.8			
			58.0	M B	20	} Tighten
			40.0	RL	20	
			47.5	R1B	19	
			38.0	G1A	19	
			16.2	AF		
		RL1	7.5	E2E		
			15.8	M 6B		La. aside
			2.0	RL		
			204.2			
G-1 Grease one jaw on the 3 jaw chuck						
		M16C	18.7	M16C		Grease gun to chuck
		P2SD	21.8	P2SD		Grease gun to fitting
Hold grease gun		G2	5.6	G2		
			36.0	M2A5	6	} Pump grease
			27.6	M1B	6	
		M16B	9.0	M 6B		Gun to body
			125.5			

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
H-1 Place spider in 3 jaw chuck and remove						
			22.1	M20C		Spider to chuck
			52.1	P3SSD		
			20.4	M1C	6	} Into chuck
			33.6	G2	6	
To spider		R10D	12.9			
		G3	5.6			
			5.9	R2D		
			2.0	G1A		
			6.0	M1C	3	} To exact location
			16.8	G2	3	
			16.2	AP1		Hold against back of chuck
		RL1	2.0			
To balance		R10E	10.5			
			2.0	RL1		
			11.8	R12E		To balance
			14.2	R12D		To spider
			2.0	G1A		
			52.1	P3SSD		Remove spider
			20.4	M1C	6	
			28.0	G2	5	
			18.2	M20B		To body
			354.8			
J-1 Reposition one back stop in chuck						
			10.1	R6D		To stop
			2.0	G A		
			10.2	M1C	3	Reposition
			21.9	EF	3	Look
			2.0	RL1		
			8.0	R6E		To balance
			64.2			
L-1 Put Chuck, fixture or face plate on spindle nose						
			31.0	M20B30		To board on bed
Same motion pattern			5.6	G2		
			16.1	AF		
			17.5	M18C		Mount on spindle nose
			5.6	G2		
			10.2	M1C	3	Align holes
			1.8	F3SD		
			5.6	G2		
			16.1	AP1		Seat against nose
			2.0	RL1		
			156.1			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
M-1 Remove chuck, fixture or face plate from spindle nose						
Same motion pattern			5.6	G2		
			33.4	M18B30		To board on bed
			5.6	G2		
			16.2	AP1		
			35.0	M20B30		To body
			95.8			
N-1 Open or close air chuck valve			29.0	S		
			12.9	R12B		To valve
			10.0	G1A	5	} Open or close
			40.0	M5B	5	
			10.0	RL1	5	
			31.2	R5B	4	
			31.9	AS		
			165.0			
P-1 Set air chuck pressure			29.0	S		To valve
			10.0	G1A	5	} Open or close valve
			27.0	T90S	5	
			10.0	RL1	5	
			21.6	T90S	4	
			14.6	EF	2	Look at pressure gauge
			21.7	AS		
			144.1			
Q-1 Set pressure of spring chuck			9.7	M10C		Rod to tension nut
			120.6	P2SD	6	Rod into hole of nut
			36.6	G2	6	
			140.4	M10B10	6	Turn nut
			37.5	R2B	6	
			67.5	M10C		To other hole
			5.8	M10B		Rod to body
			411.3			
R-1 Open and close chuck jaws (spring chuck)						
			SS12C1	17.0		
To lever			R22B	20.1		
Open jaws			M10A10	16.4		
			RL1	2.0		
To balance			SS12C1	17.0		
To lever			R12B	12.9		
			G1A	2.0		
			SS12C1	17.0		
Close jaws			M10C			
			RL1	2.0		
To balance			SS12C1	17.0		
			123.4			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
S-1 Open and close chuck jaws (air chuck)						
To valve lever		R20B	18.6			
		G1A	2.0			
Open		M6B	8.9			
		RL1	2.0			
			31.5			
Close			31.5			
			63.0			
T-1 Place and remove part from 3 jaw chuck						
			8.0	M4C		Part to chuck
			16.2	F2SE		
			6.7	M3C		Into chuck
			5.6	G2		
			2.0	M6C		
			2.0	RL1		
			16.7	R20E		To balance
				R20B		Limited out by
						Element R-1
			2.0	G1A		
			6.9	M4B		Remove part
			66.1			
U-1 Lay aside and obtain new part under 5#						
			19.8	M1B		To body
			18.6	M5		
			14.6	M4B		Lay in box
			2.0	RL		
			14.4	R14C		To another part
			2.0	G1A		
			4.6	M4C		Remove part
			18.6	B1		
			15.8	M1B		Handling device
			62.4			
V-1 Set workhead spindle speed						
		SS16C	18.6			
To switch button		R40	5.6			
		G1	2.0			
Open contact		AF1	10.6			
		RL2	2.0			
To knob		R5B	7.8			
		G1A	2.0			
Turn knob		M4C	8.0			
		G2	5.6			
Close contact		AP1	16.2			
		RL1	2.0			
To balance		SS 60C	19.8			
			124.8			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.N.	TNU	R.N.	No.	Description-Right Hand
W-1 Set table traverse speed (hydraulic)						
			15.8	R16B		To traverse lever
			2.0	G1A		
			7.8	R5B		With thumb
			16.8	G2	3	Adjust speed
			10.2	M1C	3	
			2.0	RL1		
			<u>34.6</u>			
X-1 Run down each nut by hand						
			20.0	R2B	5	
			10.0	G1A	5	
			23.0	M2B	5	Run down nut
			16.2	AP1		Hand tighten
			10.0	RL1	5	
			<u>79.2</u>			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No	Description-Right Hand
A-2 Move each screw to hole and engage						
	15.8		R16B			To screw
	2.0		G1A			
	18.7		M16C			To hole
	5.6		P1SE			
	8.0		M4C			To thread
	16.2		P2SE			
	18.4		M2B	4	}	Engage thread
	8.0		RL1	4		
	12.0		R2B	3		
	6.0		G1A	3		
	110.7					
B-2 Run down each screw by hand						
	30.0		G1A	15	}	Turn screw
	46.4		M1B	16		
	37.5		R1B	15		
	16.2		AP1			Hand tighten
	32.0		RL1	16		
	162.1					
C-2 Run out each screw b. hand and lay aside						
	1.5		R10B			To screw
	32.0		G1A	16	}	Run out
	46.4		M1B	16		
	32.0		RL1	16		
	37.5		R1B	15		
	4.0		D1E			Remove screw
	13.4		M12B			Lay aside
	2.0		RL1			
	179.8					
D-2 Tighten or loosen each screw or nut with wrench						
	12.7		M4C			Wrench to screw
	19.7		P2SSE			On screw
	32.4		AF1	2	}	Tighten or loosen
	13.8		M4B	2		
	5.6		G2			
	4.0		D1E			
	88.2					
E-2 Place each washer on stud						
	15.8		R16B			To washer
	3.5		G1B			
	18.7		M16C			Washer to stud
	16.2		P2SE			
	2.0		RL1			
	55.2					

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TNU	R.H.	No.	Description-Right Hand
F-2 Remove and lay aside each washer			15.8	R16B		To washer
			3.5	G1B		
			7.5	D2E		Remove
			15.8	M16B		Lay aside
			2.0	RL1		
			<u>44.6</u>			
G-2 Lock and unlock workhead spindle						
To lock pin		R16D	17.0			
		G5	.0			
Lock spindle		AP2	10.6			
		M1A	2.5			
		RL2	.0			
To lock pin		R16D	17.0	<u>R16D</u>		To spindle
		G1A	2.0	G1A		
			9.7	M2C10		Turn spindle
		M1B	2.9			
		D2E	7.5			
		RL1	2.0	RL1		
			<u>71.2</u>			
H-2 Index barrel stop one position			40.7	SS18C2		
			29.0	B		
				R16D		To barrel stop
			2.0	G1A		
			6.7	M3C		Index
			2.0	RL1		
			31.9	AB		
			40.7	SS18C2		To balance
			<u>153.0</u>			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand No. L.H. TDU R.H. No. Description-Right Hand

J-2 Move one table reverse or stop dog

		12.9	R12B		To lock screw
		10.0	G1A	5	} Loosen
		16.2	AP1		
		14.5	M1B	5	
		10.0	RL1	5	
		10.0	R1B	4	} To dog
To adjusting screw	R10B	11.5	R1B		
	G1A	2.0	G1A		
Disengage	D2E	7.5			
	M1A	2.5			
		21.3	M2B5	3	} Move dog 6"
		11.2	G2	2	
	G2	5.6			
Engage adjusting screw	M1C	3.4			
	AP2	10.6			
	RL1	2.0	RL1		
		5.3	R3B		To lock screw
		10.0	G1A	5	} Tighten lock screw
		14.5	M1B	5	
		8.0	RL1	4	
		10.0	R1B	4	
		16.2	AP1		
		2.0	RL1		
		217.2			

L-2 Adjust one table reverse or stop dog.

	12.9	R12B		To adjusting screw
	6.0	G1A	3	} Turn screw
	10.2	M1C	3	
	6.0	RL1	3	
	5.0	R1B	2	} Lock
	0.4	EF	1	
	0.4	R 2E		To balance
	3.5			

M-2 Raise or lower stop dog tongue

	10.6	SS18C		To stop
	16.4	R 4B		
	2.0	G1A		
	4.4	M3A		Raise or lower tongue
	2.0	RL		
	20.6	SS18C		To balance
	64.5			

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FORMULA GR-1

METHODS ANALYSIS CHART

Description-Left Hand No. L.H. TNU R.H. No. Description-Right Hand

H-1 Insert and remove diamond in holder

Diamond to holder	M20C	22.1
Into holder	P2SE	16.2
	RL1	2.0
To balance	R20B	16.7
To diamond	R20B	18.6
	G1A	2.0
Remove	B2E	7.0
	M20B	18.2
		<u>102.8</u>

P-2 Set truing unit for automatic diamond rise

	R20B	18.6	R20B		To arm
	G1A	2.0	G1A		
3	AP1	48.6	AP1	3	To position
3	M2C	6.0	M2C	3	
3	G2	16.8	G2	3	
		21.9	EF	3	
	RL1	2.0	RL1		
		<u>119.9</u>			

Q-2 Set trip for automatic diamond rise

	29.0	B			
	12.9	R12B			To trip
	2.0	G1A			
	8.7	M2B	3	Move trip 3"	
	16.8	G2	3		
	2.0	RL1			
	31.9	AB			In balance
	<u>103.3</u>				

R-2 Move truing unit forward or back 3"

	R22B	20.1	R22B		
	G1A	2.0	G1A		
2	AP1	32.4	AP1	2	Move 3"
2	M2C	4.0	M2C	2	
	M3C5	9.3	M3C5		
	G2	5.6	G2		
	P2SSE	7.7	P2SSE		
	RL1	2.0	RL1		
	R22E	19.0	R22E		
		<u>113.1</u>			

FORMULA CR-2

MECHANICAL ANALYSIS CHART

Description-Left Hand No. L.H. T.W. R.H. No. Description-Right Hand

S-2 Move truing unit base 3"

			21.5	R24B		To truing unit base
			2.0	G1A		
			32.4	AP1	3	Loosen base
			4.0	MFB	2	
			5.6	G2		
			20.6	S018C1		
To base		R20B	18.6			
		G1A	2.0			
			5.6	G2		
	3	AP1	48.6	AP1	3	Move unit base 3"
	3	M1C10	23.1	M1C10	3	
	2	G2	11.2	G2	2	
		RL1	2.0	RL1		
		<u>R20B</u>	<u>19.2</u>	R24B		To balance
			216.4			

T-2 Raise or lower wheel truing diamond (by hand)

22.9	R24B	To lever
2.0	G1A	
8.1	MFA	Raise
2.0	RL1	
<u>22.9</u>	R20B	To balance
57.9		

U-2 Mount and remove wheelhead

		12.9	R10D		To wheelhead
		2.0	G.A		
		16.2	AP1		
		40.2	M20C30		Wheelhead to machine
		5.6	G2		
		16.2	AP1		
		28.8	M10C30		Wheelhead to position
		26.6	F2WSP		
		24.5	M6C30		Mount
		26.6	F2WSD		
		5.6	C2		
		18.9	M10C10		
Same motion pattern		2.0	RL1		
		12.9	R10D		To wheelhead
		2.0	G.A		
		32.4	AP1	2	Loosen
		4.0	MFA	2	
		16.2	AP1		
		14.1	M5C10		
		16.8	G2	3	Remove
		4.0	MFC	2	
		14.1	M5C10		
		11.8	D2D		
		5.6	C2		
		51.6	M10C30		La. raise
		2.0	RL1		
		<u>43.6</u>			

MECHANICAL ANALYSIS CHART

Description-Left Hand	No.	L.H.	TSU	R.H.	No.	Description-Right Hand
V-2 Place shim under wheelhead						
To shim		R16B	15.8			
		G1B	3.5			
Shim to wheelhead		M16C	18.7			
			15.8	R16B		To wheelhead
			2.0	G1A		
			16.2	AP1		Loosen wheelhead
			13.0	M2B20		Raise
		P1MSE	10.4			
Shim under wheelhead		M3B	5.7			
		RL1	2.0			
			13.0	M2B20		Lower
			2.0	RL1		
			<u>118.1</u>			
W-2 Remove shim from under wheelhead						
			15.8	R16B		To wheelhead
			2.0	G1A		
			16.2	AP1		Loosen wheelhead
To shim		R16B	15.8	M2B20		Raise
		G1B	3.5			
Remove		M3B	5.7			
			13.0	M2B20		Lower
Layside		M16B	15.8	RL1		
		RL1	2.0			
			<u>89.8</u>			
X-2 Block wheelhead spindle to remove and mount quill						
			15.8	R16B		To block
			2.0	G1A		
			13.5	M10C		To pulley
			11.2	G2	2	Position block
			4.0	MFC	2	
			2.0	RL1		
			11.5	R10B		To oil
			2.0	G1A		
To wheelhead spindle		M10C	13.5	M10C		Pin to pulley
		G1A	2.0			
Turn spindle		M5C	9.2			
			16.2	P2SE		Pin into pulley hole
Turn spindle	2	G2	2.2			
and hold	2	MFC	4.0			
			2.0	RL1		
			16.7	R20R		To balance
			26.7	R30D		To pin in pulley
			2.0	G1A		
			8.9	M6B		Lock side of & hold
			5.6	C2		
			7.5	L2E		Remove pin

FORMER 08-2

MEASURES ANALYSIS CHART

Description-Left hand	No.	L.H.	T.W.	R.H.	No.	Description-Right Hand
X-2 (continued)			8.6	R6B		To block
			2.0	G1A		Pin pin
			12.2	M6B		Lay pin and block aside
			2.0	RL1		
			217.3			
Y-2 Remove and mount grinding wheel on quill		G2	5.6			
Remove wheel and screw from quill		M14B	14.6	R6B		To screw
			2.0	G1A		
			4.6	M2B		Have screw in wheel hole
			5.6	G3		Grasp wheel
To screw		R2B	4.0			
		G1A	2.0			
			2.9	M1B		Remove wheel from screw
			7.5	D2B		
			15.8	M16B		Lay wheel aside
			2.0	RL1		
			5.9	R2D		To block
			3.5	G1B		
			10.3	M6C		Blocker to screw
			16.2	P2SE		Blocker on screw
			2.9	M1B		
			2.0	RL1		
			8.6	R6B		To wheel
			2.0	G1A		
			10.3	M6C		Wheel to screw
			16.2	P2SE		Wheel on screw
			2.9	M1B		
			5.6			
			2.0	RL1		
			10.3	R6D		To block
			3.5	G1B		
			10.3	M6C		Blocker to screw
			16.2	P2SE		Blocker on screw
			2.9	M1B		
			2.0	RL1		
Wheel to quill		M16C	14.7			
Mount on quill		P2SE	16.2			
		M1B	2.9			
		RL1	2.0			
			239.4			

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
I-2 Mount and remove wheelhead drive belt						
			12.9	R12B		To belt
			2.0	G1A		
To belt		R20B	20.6	M24B		Belt to wheelhead
		G1A	2.0			
Belt to motor Pulley		M12C	15.2	M6B		
Mount belt	{	G2	16.8			
	3	M1C	10.2			
			7.3	M5A		Draw belt to wheelhead pulley
			16.8	G2	3	
			10.2	M1C	3	Mount belt
To motor pulley		RL1	2.0	RL1		
		R18D	18.4	R8B		To wheelhead pulley
		G1A	2.0	G1A		
		M4C	8.0			
Remove belt	{	G2	11.2			
	2	M5C	18.4			
	2	RL1	20.6	M24B		Remove belt & lay aside
			2.0	RL1		
To balance		R12E	11.8	R12E		To balance
			208.4			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand No. L.H. TIME R.H. No. Description-Right Hand

A-3 Tighten and loosen wheelhead drive belt

	14.4	R14B	To motor
	.0	G3	
Use both hands	17.0	SS12C1	} Tighten belt
	16.2	AP1	
	10.7	M4A10	
	2.0	RL1	
	26.7	R30B	To rear of motor
	2.0	G.A	
	16.2	AP1	} Loosen belt
	10.7	M4A10	
	2.0	RL1	
	22.9	R30E	To balance
	140.8		

B-3 Swivel the work head 1/2" taper per foot

	40.7	SS19C2	
	15.8	R16B	To worm knob
	16.0	G1A	8
	129.6	T906	8 Swivel workhead
	16.0	RL1	8
	37.8	T90S	7
	40.7	SS19C2	
	296.6		
Each addition 1/2" taper	199.4		

C-3 Swivel workhead to adjust taper or align lead

	40.7	SS19C2	
	15.8	R16B	To worm knob
	2.0	G.A	
	16.2	T90L	Swivel workhead
	2.0	RL1	
	40.7	SS19C2	
	179.4		

D-3 Raise and lower grinding wheel guard by hand

To guard	(R.OB)	20.4	R22B	To motor
	G1A	2.0	G.A	
		12.0	M3B	} Disengage
		21.0	D3E	
		2.5	M.A	
Raise guard	M18C	20.4		
Align holes	MFC	9.0	(MFC)	} Engage lock pin
	P3SD	48.6	P3SD	
		2.5	M1A	
	RL	2.0	RL1	
	R.F	18.0	R22E	To balance
		59.0		
Lower		159.0		
		378.0		

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
K-3 Reverse table traverse by hand						
To lever		R6B	10.1			
		G1A	2.0			
Reverse Table		AP1	16.2			
		M3A	4.9			
		RL1	2.0			
			<u>35.2</u>			
F-3 Move table by hand one-half inch						
			17.0	SS12C1		
To engaging lever		R6B	8.6	R6B		To hand wheel
		G1A	2.0	G1A		
Pull lever up		AP1	16.2			
		M1A	2.5			
		G2	18.7	M16C		Turn hand wheel
Final lever engagement		AP1	16.2			
		M1A	2.5			
			5.6	G2		
			19.6	1C10		Move table 1/2"
		G2	5.6	RL1		
Disengage		AP1	16.2			
		M2A	3.6			
		RL1	2.0			
			<u>17.0</u>	SS12C1		
			153.3			
Each additional 1/2"			14.4			
G-3 Raise and lower workhead guard						
To guard handle		R16B	15.8			
		G1A	2.0			
Raise guard		M20C	22.1			
		RL1	2.0			
To balance		R30E	22.9			
To guard		R30B	25.8			
		G1A	2.0			
Lower guard		M20C	22.1			
		RL1	2.0			
			<u>116.7</u>			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
H-3 Mount and remove front or rear splash guard						
			29.0	B		To guard on floor
			2.0	G1A		
			31.9	AB		
			20.4	M18C		To machine
			21.0	P2NSE		Or machine
			9.1	P1SSE		
			2.0	RL1		
			11.5	R10B		To guard
			2.0	G1A		
			4.0	D1E		Remove
			8.9	M6B		
			19.0	B		Lay aside
			2.0	RL1		
			31.9	AB		To balance
			204.7			
J-3 Move wheelhead cross slide (Set-up)						
			10.1	R8B		To hand wheel
			2.0	G1A		
			149.2	10C10		Move .300"
			2.0	RL1		
			163.3			
L-3 Move wheelhead cross slide (operation)						
			10.1	R8B		To hand wheel
			2.0	G1A		
			18.0	3/-C10		Crank to approximate position
			2.0	RL1		
			12.9	R12B		To hand wheel
			2.0	G1A		
			10.2	M10	3	Move to exact position
			1.2	G2	2	
			11.9	EF	2	
			2.0	RL1		
			90.3			
M-3 Move Workhead cross slide one half inch						
			40.7	SS 8C2		To hand wheel
				R12C		
			2.0	G1A		
			62.8	4C10		Move one inch
			2.0	RL1		
			40.7	SS 8C2		To balance
			148.7			
Each additional 1/8"			14.4			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	LH	TMU	R.H.	No.	Description-Right Hand
N-3 Move Workhead cross slide to dial reading						
			12.9	R10D		To crank handle
			19.6	M3A	4	Tap handle with hand
			22.8	M3B	4	
			29.2	EF	4	Read dial
			2.0	RL1		
			<u>86.5</u>			
E-3 Open or close air supply for hose						
			42.9	SS20C2		To air hose
			29.0	B		
				R10B		To valve
			2.0	G1A		
			8.0	M4C		Open or close valve
			2.0	RL1		
			31.9	AB		
			42.9	SS20C2		To work area
			<u>159.8</u>			
Q-3 Tap object with hammer						
			18.7	M16C		Hammer to object
			5.6	P1SE		
			41.4	M4B	6	Hammer object
			36.6	M4A	6	
			<u>102.3</u>			
R-3 Blow off part (air)						
			12.9	R12B		To nozzle
			2.0	G1A		
			8.9	M6B		Off hook
			13.4	M12B		To part
				GF		
			10.6	AP2		Press button
			27.6	M4B	4	Blow off
			17.0	M18B		To hook
			5.2	M2C		
			5.6	P1SE		Into hook
			2.0	RL1		
			11.8	R12E		To balance
			<u>117.0</u>			
S-3 Wipe object off with cloth						
Case I - Small object						
			18.6	R20B		To cloth
			2.0	G1A		
			15.8	M16B		Cloth to part
			53.4	M6B	6	Wipe off
			18.2	M20B		Lay cloth aside
			2.0	RL1		
			<u>110.0</u>			
Case II - Large object						
Case I						
			110.0			
			53.4	M6B	6	Additional wiping
			<u>163.4</u>			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.R.	TMU	R.H.	No.	Description-Right Hand
T-3 Dress diameter of wheel with carborundum "stick"						
			12.9	R12B		To "stick"
			2.0	G1A		
			18.7	M16C		"Stick" to wheel
			400.0	EST		Dress time
			15.8	M16B		Lay aside
			2.0	RL1		
			<u>451.4</u>			
U-3 Set step on wheelhead cross slide hand wheel						
			11.5	R10B		To compensating knob
			30.0	G1A	15	
			73.5	M3A	15	Turn knob
			30.0	RL1	15	
			79.5	R3B	14	
			<u>224.5</u>			
V-3 Wipe off holding surfaces of 3 jaws with hand						
			14.2	R12D		To jaw
			17.1	M3B	3	} Wipe 3 jaws
			14.6	R3D	2	
			12.9	R12B		To balance
			<u>58.8</u>			
W-3 Bring grinding wheel to face of work with facing attachment						
			15.8	R16B		To lever
			2.0	G1A		
			5.7	M3B		
			29.2	EP	4	} Wheel to work
			8.0	M1C	4	
			2.0	RL1		
			<u>62.7</u>			
X-3 Dress face of grinding wheel with carborundum "stick" (new wheel)						
Operator has "stick" in hand after dressing diameter						
			9.2	M5C		To wheel
			250.0	EST		Dress time
			8.0	M5B		To balance
			<u>267.2</u>			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.N.	TNU	R.N.	No.	Description-Right Hand
Y-3 Dress face of grinding wheel with carborundum "stick" (operation)						
	12.9		R12B			To "stick"
	2.0		G1A			
	20.4		M18C			To wheel
	75.0		EST			Dress time
	17.0		M18B			Lay aside
	2.0		RL1			
	<u>129.3</u>					
Z-3 Obtain and lay aside chuck removing board						
	18.6		TBC1			
	30.0		W2P			To bench
	29.0		S			To board
	2.0		G1A			
	31.9		AS			
	37.2		TBC2			
	30.0		W2P			To machine
	18.2		M20B			Board under chuck
	2.0		RL1			
	<u>198.9</u>					
	<u>198.9</u>					Remove & lay aside
	<u>397.8</u>					

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	THU	R.H.	No.	Description-Right Hand
A-4 Mount workhead guard						
			35.0	M20B30		Guard on bed
			5.6	G2		
Same motion			16.2	AP1		
Pattern			37.9	M18C30		Guard to workhead
			48.6	P3SD		
			5.6	G2		
			17.7	M6C15		To next position
			48.6	P3SD		
			42.4	AP2	4	
			8.0	M2B	4	
			2.0	RL1		
			267.6			
B-4 Remove Workhead guard						
			25.8	R30B		To guard
			2.0	G1A		
Same motion pattern			42.4	AP2	4	Remove guard
			8.0	M2B	4	
			22.4	G2	4	
			23.6	D2D	2	
			17.0	M18B		Lay on bed
			5.6	G2		
			16.2	AP1		
			18.2	M20B		To body
			181.2			
C-4 Remove and replace diamond holder unit						
			15.8	R16B		To unit
			2.0	G1A		
			7.5	D2E		Remove
			15.8	M16B		Lay aside
			2.0	RL1		
			43.1			
Replace			43.1			
			86.2			
D-4 Mount and remove radius dresser						
			25.6	M20C5		Dresser to truing unit
			5.6	P1SE		Align
			5.6	G2		
			2.0	M2C		
			5.6	P1SE		
			2.0	RL1		
			18.6	R20B		To dresser
			2.0	G1A		
			21.2	M20B5		Remove
			86.2			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TNU	L.H.	No.	Description-Right Hand
E-4 Additional to tighten and loosen screw with Allen wrench						
			13.5	M10C		Pipe to Allen wrench
			11.2	P1SD		
			8.9	M6B	}	Tighten screw
			16.2	AP1		
			4.0	D1E		
			12.2	M10B		To balance
			66.0			
Loosen			66.0			
			132.0			
F-4 Set radius on radius dresser						
To dresser		R12B	12.9	R6B		To diamond holder
		G1A	2.0	G1A	}	Position
			3.4	M1C		
			2.0	M2C		
			16.2	AP1		
		RL1	2.0	RL1		
			38.5			
G-4 Pick up and lay aside tool						
Same as element Z-2 in Formula GR-1			67.1			
H-4 Lay aside and obtain new part (over 5#)						
			21.4	M16B10		To body
			18.6	TBC1		
			30.0	W2P		
Same motion pattern			31.9	S		To box
			21.4	M16B10		Lay in box
			2.0	RL1		
			15.8	R16B		To another part
			2.0	G1A		
			21.4	M16B10		Remove
			31.9	AS		
			18.6	TBC1		
			30.0	W2P		To machine
			21.4	M16B10		To holding device
			266.4			
J-4 Move workhead barrel stop unit to or from indicator						
		R12B	12.9	R12B		To unit
		G1A	2.0	G1A		
	3	M1C	10.2	M1C	3	To or from indicator
	2	G2	11.2	G2	2	
		RL1	2.0	RL1		
			38.3			

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.N.	TMU	L.N.	No.	Description-Right Hand
M-4 Mount and remove part or fixture on magnetic chuck						
			6.9	M4B		To chuck
			3.4	M1C		
			32.4	P2SE	2	Align
			2.0	RL1		
			6.4	B4B		To part
			14.7	MBC5		Slide off
			7.5	B2E		
			6.9	M4B		To balance
			<u>80.2</u>			
M-4 Deburr sharp edge with stone						
			17.2	R18B		To stone
			2.0	G1A		
			25.5	M24C		Stone to edge
To jog button		R12D	14.2			
		G5				
		AP1	16.2			
			75.0	EST		Burr time
		RL2	20.6	M24B		Lay aside stone
			2.0	RL1		
			<u>172.7</u>			
Each additional sharp edge						
			8.0	M4C		
			75.0	EST		Burr time
			<u>83.0</u>			
P-4 Place bolt in chuck fixture or face plate and run in						
To bolt		R16B	15.8			
		G1A	2.0			
Bolt to chuck		M16C	18.7			
Time for restricted area		EST	100.0			
	30	M1B	87.0			
Run bolt in	30	RL1	60.0			
	29	R1B	72.5			
	29	G1A	58.0			
			<u>414.0</u>			
Q-4 Run out bolt in chuck, fixture or face plate and lay aside						
To bolt		R16B	15.8			
	30	G1A	60.0			
Run bolt out	30	M1B	87.0			
	29	RL1	58.0			
	29	R1B	72.5			
		D2D	11.8			
Lay aside		M16B	15.8			
		RL1	2.0			
			<u>322.9</u>			

FORMULA GR-2

MEASUREMENT ANALYSIS CHART

Description-Left Hand	No. L.H.	TIME	R.H. No.	Description-Right hand
R-4 Tighten or loosen bolt in chuck, fixture or 1/4 plate with wrench				
		13.5	M10C	Wrench to bolt
		73.9	P288D	3
		31.8	M10B	3 Tighten
		22.5	D2E	3
		23.6	M10C	2
		32.4	API	2
		12.2	M10B	Wrench to body
		<u>211.9</u>		
S-4 Move indicator to part				
		15.8	R16B	To indicator stand
		2.0	G1A	
		12.2	M10B	To work
		5.6	G2	
		5.2	M10C	Indicator to work
		16.2	P28E	
		2.0	RL1	
		<u>11.8</u>	R12E	To balance
		<u>70.8</u>		
T-4 Remove one finger back stop in chuck				
		12.9	R12B	To wrench
		2.0	G1A	
		18.7	M10C	Wrench to screw
		25.3	P288D	
To nut	R14D	15.6		
	G1A	2.0		
		5.6	G2	
		58.0	M1B	20
		40.0	RL1	20 Loosen
		47.5	R1B	19
		38.0	G1A	19
		7.5	D2E	
	G2	5.6	G2	Palm wrench
			M2B	
		8.4	R4D	To stop
		2.0	G1A	
Remove and lay aside nut M16B		15.8	M16B	Remove and lay aside stop
	RL1	<u>2.0</u>	RL1	
		<u>306.9</u>		

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TSU	R.H.	No.	Description-Right Hand
U-4 Stone sharp edges of 3 jaws						
			17.2	R12B		To stone
			2.0	G1A		
			20.6	M24B		Stone jaws
			1200.0	EST		Stoning time
			20.6	M24B		Lay stone aside
			2.0	KL1		
			<u>1262.4</u>			
V-4 Tighten and loosen thumb screw hand tight						
			12.9	R12B		To screw
			2.0	G1A		
			9.2	M2B	2	Tighten
			11.2	G2	2	
			16.2	AP1		
			2.0	KL1		
			12.9	R12B		To screw
			2.0	G1A		
			16.2	AP1		
			9.2	M2B	2	Loosen
			11.2	G2	2	
			2.0	KL1		
			<u>107.0</u>			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.N.	TMU	R.N.	No.	Description-Right Hand
W-4 Close & Open extended bridge steadyrest			40.7	SS18C2		Step to the right
To upper section		<u>RL2B</u>	21.5	R24B		To upper section of steadyrest
		G1A	2.0	G1A		Swing down
Swing down		<u>M6C</u>	13.5	M10C		Align
			5.6	G2	}	
			2.0	M6C		
			2.0	RL1		
			10.1	R8B		To clamp
			2.0	G1A		
			8.9	M6B		Swing clamp up and secure steadyrest
			16.2	AP1		
	RL1		2.0	RL1		
Hand to balance	R12E		11.8	R12E		Hand to balance
			40.7	SS18C2		To work area
			40.7	SS18C2		Step to left
			12.9	R12B		To clamp
			2.0	G1A		
			16.2	AP1	}	Remove steadyrest clamp
			8.9	M6B		
			2.0	RL1		
To steadyrest	R16B		15.8	<u>R8B</u>		To steadyrest
	G1A		2.0	G1A		
Swing up	<u>M6C</u>		23.8	M22C		Swing up
	RL1		2.0	RL1		
Hand to balance	R24E		19.2	R24E		Hand to balance
			40.7	SS18C2		Step to left
			365.2			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMS	R.H.	No.	Description-Right H
X-4 Move workhead on extended bridge 36" (average)						
			150.0	W10P		To rear of machine
Crank to pinion		M6C	10.3	M6C		Crank to pinion
Crank on pinion		P28SE	19.7	P28SE		Crank on pinion
		M1A	2.5	M1A		
		RL1	5.6	G2		
			200.5	5-C6 ⁴⁰		Move workhead 12"
				SS12C1		
			2.0	RL1		
To rack		R12B	12.9	R12B	2	Loosen nut element
		G1A	2.0	G1A		To crank
Move pinion to new pos.		M12B	68.7	5C6		Move pinion to new p
		RL1	2.0	SS12C1		
				RL1		
			12.9	R12B	2	Tighten nut element
			2.0	G1A		To crank
			200.5	5-C6 ⁴⁰		Move workhead 12"
				SS12C1		
			2.0	RL1		
To rack		R12B	12.9	R12B	2	Loosen nut element
		G1A	2.0	G1A		To crank
Move pinion to new pos.		M12B	68.7	5C6		Move pinion to new p
		RL1	2.0	SS12C1		
				RL1		
			12.9	R12B	2	Tighten nut element
			2.0	G1A		To crank
			200.5	5-C6 ⁴⁰		Move workhead 12"
				SS12C1		
			5.6	G2		
			8.9	M6B		Remove crank
			18.6	TBC1		
			195.0	W13P		To front of machine
			1222.7			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.N.	TNU	R.N.	No.	Description-Right Hand
Y-4 Mount steadyrest on extended bridge & remove						
To steadyrest		R12B	29.0	S		To steadyrest
		G1A	12.9	R12B		
			2.0	G1A		
			31.9	AS		
			18.6	TBC1		
Lay steadyrest on swivel plate		M16C ²⁵	34.0	W2PO		To bridge
			33.0	M16C ²⁵		Lay steadyrest on swivel plate
		G2	5.6	G2		
Steadyrest to slot		M6C10	15.3	M6C10		Steadyrest to slot
keyway into slot		P38SD	52.1	P38SD		keyway into slot
		G2	5.6	G2		
Slide steadyrest on plate and hold		M2C10	9.7	M2C10		Slide steadyrest on plate
			2.0	RL1		
			10.1	R6D		To "T" bolt
			2.0	G1A		
			19.7	P28SE		Align "T" to slot
			2.0	RL1		
			12.9	R10D		To 2nd "T" bolt
			2.0	G1A		
			19.7	P28SE		Align "T" to slot
			2.0	RL1		
		G2	15.8	R16B		To steady rest
			2.0	G1A		
Slide steadyrest to position	{ 6	M1B10	36.6	M1B10	6 }	Slide steadyrest
	{ 5	G2	28.0	G2	5 }	to position
		RL1	2.0	RL1		
Hand to balance		R12B	14.2	R16E		Hand to balance
		R12B	15.8	R16B		To steadyrest
		G1A	2.0	G1A		
Slide steadyrest to edge of plate	{ 8	AP1	16.2	AP1	8 }	Slide steadyrest to edge of plate
		M1B10	56.8	M1B10		
		G2	5.6	G2		
Remove from slot		D2D	11.8	D2D		Remove from slot
To body		M12B ²⁵	29.3	M16B ²⁵		To body
		T3C1	18.6	TBC1		
			34.0	W2PO		
			29.0	S		
Lay aside		M12B ²⁵	26.3	M12B ²⁵		Lay aside
		RL1	2.0	RL1		
			31.9	AS		To balance
			700.0			

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
Z-4 Set one steadyrest jaw to part						
To jaw and hold		R16B	15.8	R16B		To jaw adjusting screw
		G1A	80.0	G1A	40	Turn screw to move jaw
			116.0	M1B	40	
		RL1	80.0	RL1	40	
			100.0	R1B	39	
Hand to balance		R16E	14.2	R16E		Hand to balance
			406.0			

A-5 Adjust one steadyrest jaw to part

14.2	R12D		To wheelhead quill with indicator
8.0	G1A	4	Turn quill and sweep indicator over diameter of part
26.8	M3C	4	
8.0	RL1	4	
15.9	R3B	3	
29.2	EF	4	To adjusting screw
15.8	R16B		
20.0	G1A	10	Turn screw to move jaw
20.0	M1B	10	
20.0	RL1	10	
18.0	R1B	9	
73.0	EF	10	Look at indicator
268.9			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TEN	R.H.	No.	Description-Right Hand
4 Set one steadyrest jaw to part						
To jaw and hold		R16B	15.8	R16B		To jaw adjusting screw
		G1A	30.0	G1A	40	} Turn screw to move jaw
			118.0	M1B	40	
		RL1	20.0	RL1	40	
			100.0	R1B	39	
Hand to balance		R16E	14.2	R16E		Hand to balance
			406.0			

5 Adjust one steadyrest jaw to part			14.2	R12D		To wheelhead quill with indicator
			8.0	G1A	4	} Turn quill and sweep indicator over diameter of part
			26.8	M3C	4	
			8.0	RL1	4	
			15.9	R3B	3	
			29.2	EF	4	} To adjusting screw
			15.8	R16B		
			20.0	G1A	10	} Turn screw to move jaw
			20.0	MFB	10	
			20.0	RL1	10	
			18.0	RFB	9	
			73.0	EF	10	Look at indicator
			268.9			